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BRITISH JOURNAL OF INDUSTRIAL MEDICINE

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THE BRITISH TRADITION IN INDUSTRIAL HEALTH*

BY

E. R. A. MEREWETHER

From the Factory Department, the Ministry of Labour and National Service

(RECEIVED FOR PUBLICATION, JULY 5, 1948)

We meet, Mr. President, Ladies, and Gentlemen, to honour the memory of John Crosthwaite Bridge. By so doing we inspire ourselves, for that which is worthy of honour is worthy of emulation. Work well done flows from the application of principles, and principles are the code of experience and the lineage of tradition.

That we have gained a national tradition in industrial health is due in great measure to the work of medical pioneers, and it will be a fitting tribute to Bridge, who did so much to foster and develop our British tradition, if we try to distil from this unique heritage its essential principles and to carry on his work and that of his fellow pioneers.

Industrial Legislation

If, then, in our genetic analysis, we examine the state of industrial health and look back at its mode of development, I am afraid we shall be disappointed if we expect to find a series of legal mileposts marking the speedy fruition of great humanitarian conceptions. Yet Parliament has been by no means idle during the past hundred and fifty years, and has enacted many statutes bearing on social evils and has reversed a few; but there is little evidence that the successive reforms which came about were inspired by some magnificent, if misty and far distant, vision of a state of complete industrial health.

Such visions are seen first by men, and only later—and often in the guise of portents—by Parliaments. Perhaps it is better so, lest they bear the emptiness of the mirage rather than the promise of the rainbow. It seems that Parliament legislated with little more in mind than the provision of *ad hoc* remedies for conditions of work which had become scandalous, and, being obsessed with consequences rather than causes, in solving local issues, it ignored national problems.

We may think that in this, as in other legislation, Parliament was at first understandably addicted to homeopathic ideas. Its treatment of social evils was distinguished by remedies exhibited in frequent minute doses, and was entirely empirical and symptomatic. As so often in our history, the patient miraculously survived, to the astonishment of the world and the admiration of ourselves, without recourse to more than the most minor surgery. Nevertheless, with the physician flitting from symptom to symptom and organ to organ, prescription piled upon prescription, and instruction upon instruction. Small wonder, then, that the patient became exasperated and the relatives and nursing staff exhausted and bewildered. Therefore, every twenty or thirty years or so, a major effort would be made to cure quickly, safely, and pleasantly. New knowledge was tapped and a brave new prescription issued on orthodox lines. In this, the dosage was stepped up, particularly that of the corrigens, and the greatest thought given to the vehicle, so that an agreeable form was imparted to the medicine, at least, temporarily. This is what is called a Consolidating Act!

We shall find, therefore, in this legislation, many signs of a restricted field of vision, and but little evidence of bold and comprehensive planning such as there are indications of today. Thus, in relation to child labour, it seems that when Parliament considered chimney sweeping, cotton spinning was outside its range of vision, and it was blind to this problem in coal mines for yet another half century. Again, it thought a lot about apprentices, but little about the exploitation of the labour of "free" children. Surely all children, wherever employed, were in need of care and protection.

Most remarkably, although the advent and rapid extension of power-driven machinery did not, as is often thought, initiate the scandal of child labour, but merely concentrated it and so forced attention, it did import an even more compelling accident toll, which was ignored for over forty years. Furthermore, in 1856, fifty-four years after the enactment of the "Act for the preservation of the

* The first John C. Bridge Memorial Lecture, delivered before the Association of Industrial Medical Officers at the London School of Hygiene and Tropical Medicine on April 30, 1948.

Health and Morals of Apprentices and others employed in Cotton and other Mills and Cotton and other Factories," Parliament actually passed an Act which specifically reduced the fencing requirements for overhead shafting, and so made it easier for accidents to occur.

This followed the formation of the Factory Law Amendment Association which was merged into the National Association of Factory Occupiers, referred to by Dickens in "Household Words" in 1855 as the Association for Mangling Operatives. It also petitioned for the removal of Mr. Leonard Horner, one of the first four factory inspectors.

Reasons for the Inadequacy of Legislation

This course of action and associated legislation, with its limited scope and *ad hoc* character, its piecemeal application and its failure to deal effectively with first causes, caused so much confusion that by 1875 the law on Factories and Workshops alone was contained in no less than nineteen statutes, and a Royal Commission was appointed to go into the matter. Legislation is a drug, essential for Governments, and, being essential, it is liable to be dangerous, and when in any way it fails in action we can profit by searching for the cause.

In this case it could not be due to ignorance of the subject matter or to its triviality, for the evidence was all too clear; nor to a low standard of justice in a nation which had abolished slavery in distant parts and the death penalty at home for 144 out of 150 crimes so punishable; nor were we as a nation indifferent to the ancient virtues. Nor was it due to lack of intelligence in our law-givers: we may arrogate to ourselves a higher level of intelligence today, but in fact, there is no evidence that we have improved one iota in this respect since classical times.

Nor will the explanation be found in any failure in altruism and personal courage, in common sense and resourcefulness, or in slackening in duty and tenacity of purpose amongst the pioneers of social reforms of those times. The violent opposition and bitter controversy aroused by these philanthropists, who were to be found in all circles, including members of the Government, employers and workers, doctors and engineers, and the first four factory inspectors—Horner, Saunders, Baker, and Stuart—is sufficient proof of this.

As an illustration, listen to this petition of 1855 to the Home Secretary for the dismissal of Mr. Horner, presented by the National Association of Factory Occupiers to the Rt. Hon. Sir George Grey, Her Majesty's Secretary of State for the Home Department:

> "We, the undersigned, occupiers of Factories in the district of Mr. Leonard Horner, beg to submit that the conduct of that gentleman, from his first entrance on the administration of his office to the present day, has been harsh, unfair, and injudicious; has therefore naturally created a strong feeling of distrust towards him, and increased the unpopularity of an unequal and unpopular Act of Parliament.
>
> The continuation of Mr. Horner, in his present office being, therefore, calculated to bring the law into still greater disrepute, and the Government into frequent, unnecessary, and injurious collision with the people, we earnestly solicit his removal."

What, then, explains the apparent prostitution of conscience by expediency to be found in this earlier legislation, which on occasions even tended to depress the standards of the good employers to that of the lowest? Undoubtedly the chief cause of the failure of government was the overwhelming pressure of events. Wars and their aftermaths, revolutions and the fear of them, dismemberment of countries and failures of crops, famines and epidemics of cholera and typhus, all brought misery and intensified existing hardships, and brought slumps in trade to a feverishly expanding, but young and unstable industrial instrument, which in turn, intensified distress and national insecurity.

Influence of Public Opinion

No wonder public opinion got far ahead of parliaments and, disappointed in their rulers, the people set about to think, plan, and act in innumerable small circles of devoted humanitarians, aided by the spread of newspapers, pamphlets, and novels, and by railway transport. Trade revived, and thus began a steady advance in national health and happiness. Governments took the credit, but the British people saved themselves.

I have discussed this at some length, because the upheavals of the first half of the nineteenth century caused a change from government by politicians through Parliament to government by the people through Parliament. Since then, and until now at any rate, public opinion has continued to be ahead of parliamentary action, and this has an important bearing on the development of industrial health.

Inductive versus Deductive Methods

This method is predominantly inductive and highly characteristic of the mode of development of industrial health in this country—our tendency is to deal with particular events and circumstances, and to encourage general conclusions to emerge, on which Parliament may act. A number of countries have followed our example, but many,

particularly those more recently developing this social service, tend to work the other way round, and attach more importance to planning detailed action from pre-formed gallant principles.

Of course, the distinction cannot be clear-cut in practice, but the difference between the predominantly inductive characteristics of our procedure and the mainly deductive methods of some other countries, explains many idiosyncrasies in national thought and practice. Which is the quicker method in the long run of achieving the national aims of industrial health, it is hard to say: as to which is the better method, naturally I think that ours best suits our national needs. In point of fact, however, we had no choice.

While incendiary bombs were falling the fires had to be put out with the means at hand, without wasting time planning a national fire service. Moreover, good planning cannot be done without basic data, and there were none; so the pioneers had to set about getting them, and it was from their reports, and brave efforts, singly and in company, in little private committees and societies, that reforms sprang up and industrial health services germinated. From such beginnings arose all the fact-finding investigations, the boards, the committees, and the commissions which examined the problems thus brought to light, and reported the facts on a national scale with a view to remedying a social evil by operation of the law. So we see that traditionally, industrial health is secured by legislation, the quality of which is dependent on the accuracy of essential data.

Working out a Problem

Let us look at it another way. If we are confronted with an industrial health problem, the first question we ask is, "What are the facts?" and the next, "Are these all the facts?" Then almost invariably we find that although the problem is inherently medical, the chemist or the physicist, the management or the workers, the psychologist or some other experts have vital roles to play in solving the problem.

This sounds ridiculously simple today, but it was not always so, for if we analyse the procedure, we find it involves: (*a*) the use of basic knowledge of industrial health; (*b*) the recognition of the problem; (*c*) assessment of its general scope; (*d*) its field of investigation in a particular environment; (*e*) possibly laboratory research; (*f*) collecting and assessing the results of investigation and research; and finally (*g*) applying them to a particular occupational environment; this involves, of course, (*h*) highly specialized team-work.

The team requires (*a*) to have basic and specialized knowledge, (*b*) to be critical of its limitations, (*c*) to have a passionate desire for completeness and accuracy, (*d*) to exercise sound judgment, (*e*) to appreciate that the matter may bear on other problems, national as well as local.

Thus, we progress all the way from the particular incident to the general principle; and, if the problem happens to have national implications, the process continues by way of further investigation and legislation, and returns from the general conclusion to the particular case by way of a legal duty operating in the very factory or other occupational environment in which the problem began. This is all very different from personal medicine and the diagnosis and cure of disease in an individual.

Differences between Industrial Health and Personal Medicine

Industrial health is a wholly preventive special function based on law; it is predominantly, but not solely, medical in scope, operating in the industrial environment, and it is concerned with the individual primarily as an index of that environment.

Personal medicine is wholly wrapped up in the individual. Industrial medicine is predominantly wrapped up in the occupation and the occupational environment. Thus the approaches of the two branches of medicine are fundamentally different. Personal medicine secures the nation's health by treating the individual. Industrial health secures the individual's health by treating the industrial community. Obviously personal and industrial health are integrally specialized, but specifically complementary, functions.

So it seems that industrial health originated on account of action by particular individuals about particular incidents in particular places of work, and has progressed and is progressing essentially in this way. If we could but identify the first of these actions, we could put up a memorial saying, "At this spot on such a date industrial health was born, when X thrashed Y, an overseer, for cruelty to Z, an orphan aged 5, employed in this mill."

Industrial health has progressed far since then, but the germinal focus lies in the place of work and will remain there quite properly. Essentially, therefore, industrial health is a specialized study for those who study the place of work.

As Pope said: "The proper study of mankind is man"; and we might say, "The proper study of industrial health is industry"; and the double meaning of the word "industry," which I hear is going into disuse, will not escape us.

Dangers of Inertia

There is no time to discuss all the advantages of our traditional approach to industrial health, but I should mention one of the few disadvantages, but a major one. That is, the liability to inertia at all stages, and particularly in the crowning stages of development.

It has often been a long way from the birth of a new risk, through Parliament to the general application of a new law to prevent it, and we should do everything we can to expedite the process. The new short Factories Bill, 1948, just presented in the House of Lords, does something in this direction. To quote Pope again, "The learn'd reflect on what before they knew"; and reflection can be often so interminable that a vital step in progress escapes a generation.

Dangers of Guessing

The other method of progressing from the general to the particular follows classical reasoning. Its main defect is that unless the general principle is securely based on exact knowledge—which means either deriving the general from the particular or making a lucky guess—forces may be set in motion to the detriment rather than the aid of progress—as is shown by the Nazi dogma of inherent racial superiority—a most unhappy guess, had they but known. The lucky guess means, of course, rapid progress—but we cannot afford guesses, lucky or unlucky.

Another grave disadvantage to progress of proceeding from the general to the particular on inadequate data is that it favours the opportunist amateur, medical or lay, who is omnipresent today. We have all met with sorrow these extra-territorial prophets, gifted parasites blessed with a talent for simple, if inaccurate, exposition, who, modestly conscious of the mantle of genius, inwardly despise knowledge as painfully clouding inspiration. We can appreciate their appeal to the hard-pressed, honest man of affairs, who, anxious above all things to do justice to a problem, and to himself, yet desires the achievements and potentialites of nuclear physics served up to him on half a sheet of paper in ten minutes. We should resist them at all costs.

Government, Employers, Workers

Our method of procedure stresses the essential importance of the individual in securing industrial health. In fact, it casts the responsibility for progress on every one of us working with industry, be he employer or employee, or aiding in any other way. This, incidentally, is the genesis of the tripartite system of consultation between Government, employers, and workers, which was born out of the needs of industrial health, and which happy and successful procedure we have given to the world. This system has not grown up in a day, but again, if we had time, we could trace its development from the talents and qualities of our pioneers in industrial health. They all had in high degree those qualities we most admire, and outstandingly, I think, integrity and courage; joined with a passionate desire for truth and a fierce intolerance of injustice, they were always at war against the big battalions, but they proved once again the truth of the Horatian maxim:

> "Integer vitæ scelerisque purus
> Non eget Mauris jaculis neque arcu
> Nec venenatis gravida sagittis
> Fusce, pharetra";

(but they had no Moorish javelins and no doubt their first choice would have been the Hogarthian weapon of the day!)

They thrived on opposition and the earlier ones made the Law. The latter ones, being nationally minded, acquired a reverence and a distinct affection for the Law because of its immense power for progress, inherent in its capacity for maintaining standards of quality, once they are attained, and because of the necessity of maintaining minimum standards of industrial health, safety, and welfare, universally and equally.

Above all, they were men (and women of course; you will remember that Florence Nightingale was a model pioneer in an allied field in this period) of practical common sense and stability.

Our Pioneers

These compelling attributes of character are well exemplified in our pioneers of more recent date, whom we can so judge because we have been privileged to know them personally, like Legge and Bridge, and others retired from the forefront of the battle, but happily still with us to lend their wise aid in emergency.

Bridge, in all, served industrial health for thirty-four years, and the verdict of history will be, I think, that his passing marked the close of a remarkable and quite distinct period of half a century of progress in occupational medicine, due in great measure to Legge and himself.

Details of their achievements are well known to you, so I will content myself with emphasizing some outstanding features. The beginning of the half century associated with Legge, and the end, associated with Bridge, were marked by the passage of two advanced and much admired model pieces of legislation—the Factories and Workshops Act, 1901, and the Factories Act, 1937. The whole period

also covers the rise and zenith of the legislation relating to Workmen's Compensation—that unique British inspiration of social and economic justice which has been exported in various ways far and wide.

On the medical framework of such legislation, Legge and Bridge were not only the national pioneers, but were the leading international authorities. Bridge was peculiarly gifted in this field by his legal knowledge and the fine clarity of thought which he brought to bear on his vast knowledge and practical experience of occupational hazards. It was this field of work which appealed to him most, I think; in the pursuit of truth and justice he was ever on the look out for new knowledge which would provide evidence to expand and modify the Schedule of Diseases subject to compensation. He held strongly that legislation concerned with prevention should go hand-in-hand with legislation relating to compensation. The fundamental principle on which he worked, that identification of an occupational hazard, application of measures for its prevention and for the compensation of any associated personal injury should be contemporaneously and swiftly pursued, cannot be too strongly stressed and widely followed, for in this, time saved means life for many.

I would add to this postulate one other requirement for perfection, that of scientific prevision of occupational hazards, a science that is becoming steadily more effective.

Although active in public affairs, Bridge was inherently retiring and sensitive, but he had a most disarming and appealing charm of word and manner. His colleagues, especially the juniors, knew that he kept of his best for them. He was never too busy to discuss knotty points, and they never forgot how doubts and difficulties would vanish under his skilled analysis. Those who sat at his feet, like myself, have an abiding gratitude for his unobtrusive teaching and his warmth of genius.

The Future

What of the future? As knowledge of industrial health spreads, inertia dissipates, and opposition born of ignorance vanishes. Our pioneers, so sensitive to the maleficent forces they fought so tenaciously, would surely and mightily respond to the feeling of a great surge forward of which we are conscious today. There is a great call for new pioneers, but they will not now fight alone. In these latter years we are supported by an array of men and women skilled in medicine, science, and the many other activities, great and small, which contribute to industrial health. They are found in all conditions of life, and are drawn compellingly to this sphere of human endeavour, and in this connexion I, from my experience, know how continually I am indebted to them as colleagues.

However ill-equipped each of us thinks he is to grapple with the labours ahead, we will agree with Euripides that

> " a man shows best when he outshines
> himself; to climb
> that height he'll spend in labour more than
> half his days,"

and, inspired by pioneers, we ask ourselves the age-old question, " Who knowest that thou art not come to the Kingdom for such a time as this?"

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EARLY SCOTTISH ESSAYS IN INDUSTRIAL HEALTH*

BY

T. FERGUSON

From the Department of Public Health, University of Glasgow

(RECEIVED FOR PUBLICATION, JULY 5, 1948)

Long before the Industrial Revolution and the coming of the machine age, Scottish craftsmen, like their colleagues south of the Border, had their Guilds and Incorporations to safeguard their interests in professional matters and to look after the welfare of their decayed brethren. The Common Chests of the Incorporations were sustained in several ways, partly by entrance fees, partly by membership dues, partly by charitable contributions, and partly by fines imposed on members for breaches of the Incorporation code.

The Pynours

One of the many interesting crafts was that of the pynours, an ancient Aberdeen body later known as the Shore Porters' Society and first mentioned in the Burgh Records in 1498. Up to 1636, admission to the Society was easy and unrestricted; but that year candidates for admission had first to undergo a professional trial before being accepted as fully and privileged members. Such professional trials were by no means uncommon in other crafts, but the special interest of the test to be undergone by budding pynours lay in the fact that it was a test of strength, to which the candidate was subjected under the supervision of the Water Bailie; and only candidates who passed the test were licensed by the Magistrate. It is believed that this test of strength lay in ability to carry without resting a back lift of one hundredweight from the Block House at the harbour mouth to the Braid Gutter up in the heart of the town. The test was primitive but severe when the distance, a long mile, and the elevation were taken into account: and it must rank as one of the earliest Scottish examples of a test of physical capacity for work to be undertaken. No class of the community had more need to provide for old age and infirmity than the pynours, for each man's stock in trade was his physical strength, and when that failed he was dependent on others.

The Water Caddies

There were many quaint trades in Scotland in the seventeenth and eighteenth centuries and many colourful personalities. Among them must be mentioned the water caddies, a turbulent crew, who in these days made a living by selling water to the lieges of Edinburgh and other Scottish towns at a penny per stoup. They were to be seen bearing their staffs and wearing their leather aprons, their little barrels on their backs, negotiating the tenement stairs, ready to curse and brawl on the slightest provocation, a sore trial to the Magistrates.

The Coming of the Industrial Age

But the industrial age was at hand. Sir John Sinclair's analysis of the occupations of the people of Scotland at the end of the eighteenth century showed that while the largest individual group of occupations was still that associated with agriculture, a considerable number were already employed in manufactures of various kinds and in building: and that already over 13,000 families were dependent for a livelihood on work in mines and quarries. This growth of industry was viewed with concern by observers of the times. Sinclair himself saw obvious ill effects of the growth of manufactures on health: generally people went "too early to work"; in addition to which, "eager application, scanty food, and want of proper exercise enfeebles the constitution, produces nervous disorders, and brings in various infirmities which render their lives uncomfortable and hurry them on to premature old age." Lord Cockburn, in a celebrated letter to the Lord Provost of Edinburgh on the best ways of spoiling the City, wrote that mercifully Edinburgh had almost no manufactures, with their legacy of tall brick chimneys, black smoke, a population precariously fed, pauperism, disease, and crime, all in excess. John Galt, referring in his Annals of the Parish to the condition of workers in a small cotton town in his beloved Ayrshire, wrote that they

* An Address to the Association of Industrial Medical Officers, Glasgow, June 15, 1948.

had " a strong cast of unhappy melancholy," and that it cut him to the heart to see so many young men, in the rising prime of life, already in the arms of a late consumption.

Nor were complaints of the increasing tempo of life confined to industrial districts. James Cameron, surgeon in Tain, wrote that the period of daily labour there extended from five o'clock in the morning to six o'clock at night, and that among adults amusements and games of every kind had almost disappeared. " Doubtless they (the people) have of late greatly improved as to enterprise and habits of steady industry ; but while they have lost much of that laziness and waywardness imputed to the unmodified Highlander, I fear they have lost also much of his free and serenely joyous spirit." And who will say that Cameron was wrong ?

The Mills at New Lanark

There was as yet little interest in the welfare of workers, and the conditions under which they laboured were often very bad, but forces were stirring and things were already on the move. The mills at New Lanark were among the first in Britain to set new standards, far in advance of those generally prevailing, and these standards did not altogether commend themselves to the owners of textile factories in England. Mr. Bayley of Manchester addressed a series of queries to Dale about working conditions in his New Lanark factory and his questions, with Dale's replies are preserved in the files of the London Monthly Magazine for July, 1796.

It appears that the spinning rooms were from 120 to 150 feet long and from 26 to 30 feet wide, with 9-foot ceilings : that each contained about 2,000 spindles and that the number of work-people per room varied from 50 to 75. The hours of labour were eleven and a half each day—from 6 a.m. to 7 p.m., with half an hour off at nine o'clock for breakfast and an hour at two for dinner. Seven was the hour for supper ; and in half an hour after that the teaching commenced, continuing till nine o'clock. There were fully 500 scholars, and 16 teachers were employed. On Sundays those children who could not be accommodated in Church were kept busy at school, and on Sunday evenings after Public Worship there was more religious instruction. Education, except for the provision of books, was free of expense to the scholar. The supply of labourers for the mills was recruited either from the native inhabitants, from families who had been attracted to the district from other parts of the country or from Edinburgh or Glasgow, " by the number of destitute children these places constantly afford." Those who agreed to serve for a stipulated weekly wage were commonly engaged for four years ; while those children who were received from city workhouses were generally bound until they had completed their fifteenth year.

The average number of children in the boarding house serving the factory during the four years 1792–95 inclusive was 310, and the number of deaths over the period totalled nine. In the boarding house were six sleeping apartments and three children were allowed to each bed. The children slept on wooden-bottomed beds, on bed ticks filled with straw which was changed once a month. For a few months in summer the children went without shoes and stockings. Their food consisted of oatmeal porridge for breakfast and supper, with milk in season or, in winter, swats—a composition of molasses, fermented with some new beer. For dinner there was every day barley broth made from fresh beef. The beef itself was divided among one half of the children, about seven ounces to each ; the other children received about five ounces of English cheese ; with now and then a dinner of herrings in winter or fresh butter in summer. To the beef and cheese was added a plentiful allowance of potatoes or barley bread, of which last they also received an allowance every morning before going to work.

Dale reported that the workers, when too big for spinning, were as stout and robust as other young people and fit for any trade. Many of the boys subsequently became weavers ; most of the girls left the mills to take up private family service when about sixteen years of age.

The Mill at Catrine, Ayrshire

But New Lanark, though perhaps the best known, was not the only Scottish cotton mill that tried to give heed to the welfare of its workers in these early days. In the mill at Catrine in Ayrshire, which employed nearly a thousand persons, the work-rooms were well ventilated and carefully kept and the workers' houses were well built ; the workers were encouraged to become the proprietors of a house and garden. The village had a piped water supply long before its time. The good health of the work-people was something of a byword, " as unlike as possible to the pale languid-looking females too frequently to be found in similar works in great cities." Crime was almost completely absent. Child workers, especially, were looked after with some care : all lived with their parents or with friends, for Claude Alexander of Ballochmyle, the owner of the mills, was no friend of the overseers, and Oliver Twists were not invited to Catrine. Evening education followed the same lines as at New Lanark. Alexander anticipated

legislation by a century when he ruled that all workers injured in the course of their employment should receive full wages and free medical treatment until they were recovered.

The Adelphi Cotton Mills in Perthshire

The Adelphi Cotton Mills at Deanston, near Doune in Perthshire, were erected about 1786 and employed about 700 work-people. Sir John Sinclair reports that early experiences in the factory were unhappy, though wages were high. "The confinement of so many people in one house rendered the air they breathed very impure: the heat necessary in preparing the cotton kept the workmen constantly in a sweat, and extracted the nourishing juices; the noise of the machinery rendered them soon deaf; and the flying particles of cotton, and constant labour of the eye in watching the texture of the threads weakened and destroyed the sight."

Improving Conditions

By the time of the Second Statistical Account of Scotland (1845) conditions had apparently improved. The mills employed then about eleven hundred persons, young and old, and were said to contain the most perfect machinery in the kingdom. The bobbins, driven "at the amazing velocity of 8,000 revolutions per minute" were attended by children, chiefly little girls, and the work was said to form an excellent school for training the young to habits of attention and industry: "These little girls follow the employment with spirit and cheerfulness, from eight to twelve hours a day." It was added that all the workers had the privilege of leaving at any moment they chose without previous warning and without fine or punishment.

The New Factory at Deanston

The new factory at Deanston was structurally an improvement on the old. Its ventilation was better, the belts and shafting were guarded, and the solid base of stone floor had a thin covering of wood. "The floor so arranged affords the solidity of a stone floor, and the advantages of the wooden surface to the workers are a diminution of swelled ancles and rheumatic affections of the joints, often produced by working bare-footed on stone floors." By all accounts the health of the work-people was better in the new factory than in the old, and part of the improvement was attributed to improvement that had taken place in the housing of the workers. In particular, cases of rheumatism and of lung disease were said to be less prevalent among the mill workers than among agricultural labourers in the surrounding countryside.

In 1834 twenty children had been sent by the Guardians of St. Martin's Parish, London, to work in the mills at Deanston, and three years later seventeen of them were still employed there, the other three having returned to London, two to the care of relatives, the other, described as incorrigible, having been returned to the Guardians. The Guardians later wrote again to ask whether Mr. Smith, the proprietor, had openings for any more children, and the reply was in the negative: "Our own population grows so fast upon us that we have a plentiful supply of excellent children, who give us no trouble in the training, whilst those we have had from St. Martin's Parish have given us a great deal and they require constant care and looking after." Mr. Smith found, however, that, given such care, and placed not more than two in families where there were other children, the London incomers did begin to show a desire to emulate their associates in attending to their work and education. As evidence of the satisfactory health of these London children employed at Deanston there was produced a certificate issued by Andrew McAnsh, surgeon, Royal Navy, "appointed by Her Majesty's Inspector of Factories for Scotland to issue Certificates relating to the age, strength, and general appearance of children employed at Deanston Cotton Works."

Appointment of a Factory Doctor

Mr. Smith was satisfied that the improved health of his work-people "was attended by more energy and better labour; by less of lassitude and waste from relaxed attention; by fewer interruptions from sickness, and fewer spare hands to ensure the completion of work." So satisfied was he about the influence of health on industrial output that he retained, as early as 1829, apparently at a salary of £53 per annum, the services of a medical gentleman "to inspect the work-people from time to time, to give them timely advice, and, so far as possible, to prevent disease."

The medical gentleman was Mr. John Fraser, Surgeon, resident in Doune, and there is still preserved a book recording sickness absence at Deanston for the years 1829-1832. In this book was entered the name and age of every worker losing time through sickness with the duration of absence, and, in most cases, the diagnosis; and from pencil notes here and there throughout the book it is easy to deduce that Dr. Fraser experienced most of the petty annoyances and some of the misgivings about alleged sickness incapacity that beset the industrial medical officer in later days.

Sickness Absence

It is believed that at that time there were approximately 700 workers in the factory, but nothing is known about the distribution of these workers by age and sex, though there is some reason to believe that young girls formed a large proportion of the labour force. The extent of sickness absence was probably not very unlike that prevailing in our own time (Tables 1 and 2). The total number of incapacities lasting more than three days was very nearly 700 over the three-year period—approximately one incapacity per worker employed.

The conditions most frequently responsible for absence from work were influenza and upper respiratory catarrhs (544), headache (475), sepsis (142), accidents (140), dyspepsia (87), diarrhœa and dysentery (79), rheumatism (73), and eye conditions (52). Among other diseases not common nowadays were typhus (12), hysteria (9), and cholera (3). (The year 1832 saw the first great visitation of Scotland by cholera.)

Ship Builders of Greenock

Not all employers were so enlightened as Smith of Deanston but even the tough ship-builders of Greenock—where there were eight yards each employing 60 to 120 apprentices—each retained a medical man to attend to his apprentices during illness. Perhaps their high accident rate prompted this course, for, in the year ending May 1, 1841, 74 of the 790 cases treated in Greenock Infirmary were injuries, mostly the result of accidents in the yards: incidentally, 583 of the 790 admissions were cases of typhus fever.

Coal Miners and Iron Workers

For a long time the chest troubles of coal miners and iron workers were a great source of interest to Scottish doctors. In 1831 Dr. Gregory reported the case of a collier from Dalkeith whose lungs showed a peculiar black infiltration throughout, and this first report was followed by a series of papers on the same subject. Dr. Hamilton of

TABLE 1

SICKNESS ABSENCE AMONG MALE WORKERS AT DEANSTON MILL, 1829–32: APPROXIMATE NUMBER OF WORKERS OF BOTH SEXES, 700

Age	Total days lost*	No. of absences	Duration of incapacity in days							
			1	2	3	4—	10—	20—	30—	Not stated
10—	847	241	120	47	22	35	8	4	2	3
20—	503	93	34	17	9	18	5	5	2	3
30—	200	31	16	5	1	3	1	2	2	1
40—	121	17	5	4	2	3	1	—	2	—
50—	337	11	3	1	—	3	2	—	1	1
Not stated	6	4	—	1	—	1	—	—	—	2
Total ..	1,914	397	178	75	34	63	17	11	9	10

* Apart from days attributable to the 10 cases of unstated duration.

TABLE 2

SICKNESS ABSENCE AMONG FEMALE WORKERS AT DEANSTON MILL, 1829–32: APPROXIMATE NUMBER OF WORKERS OF BOTH SEXES, 700

Age	Total days lost*	No. of absences	Duration of incapacity in days							
			1	2	3	4—	10—	20—	30—	Not stated
10—	5,500	1,399	610	282	138	250	67	15	21	15
20—	3,804	745	318	145	67	149	29	17	15	5
30—	239	74	30	12	11	18	1	2	—	—
40—	41	9	2	1	—	4	1	—	—	1
50—	187	7	2	—	—	1	1	2	1	—
Not stated	1	1	1	—	—	—	—	—	—	—
Total ..	9,772	2,235	963	441	216	422	99	36	37	21

* Apart from days attributable to the 21 cases of unstated duration.

Falkirk described a similar case in 1833, his patient being a man who had been employed for forty years by the Carron Company as a moulder, " in which occupation the workmen are continually exposed to the inhalation of a fine powder, composed in great part of very finely ground charcoal." Dr. Girdwood of Falkirk had two other moulder patients similarly affected. Dr. Graham of Glasgow described a similar condition in a collier from Polmadie, as did other doctors in the West of Scotland. Dr. Thomson of Perth, who had formerly worked in Tillicoultry, described a similar case that he had seen in mining practice there ; and Dr. Archibald Makellar dealt with conditions as he saw them in the coalfield of East Lothian. " The collier," he wrote, " at last unavoidably falls a victim to lesions within the cavity of the chest, arising from the nature of his employment." He found that the ventilation of the mines in East Lothian was very much neglected, that for a generation coarse linseed oil had been burned in the miners' lamps instead of whale oil, with greatly increased production of smoke, and that from blasting operations the men inhaled much gunpowder smoke.

Dr. Stevenson of Musselburgh wrote in 1840 of the colliers there that " Almost every one is affected more or less with dyspepsia ; they are also very subject to diseases of the lungs (I would say that one in three are affected with asthma) ; but the nature of their work I should consider as often producing these, more especially as they are frequently accompanied by a kind of spit, only known I believe among colliers—I mean what is called the black spit, produced I should suppose by their inhaling small particles of coal along with the air in the pits. I was at the dissection of a young man, a collier, last winter, who died of enlargement of the heart, and on examining the lungs we found them completely gorged with fluid, which, when squeezed out with the hand, had just the appearance of ink : this young man had not been at the pits for some weeks previous to his death." Dr. Stevenson advocated the provision of improved air in collieries, with, if necessary, the use of respirators, as well as control of colliery accidents and of the employment of children in collieries ; he thought that mines should be under similar control to factories. A neighbouring practitioner, Dr. Allison of Tranent, also knew well that mining was an unhealthy trade. From statistical survey of thirty-five colliers' families he found the average age for each male head of the family to be 34 years, whereas the average age of thirty-five heads of farmer families in Tranent was over 51 years. Many of the miners were in bad health, suffering from " difficulty of breathing, cough, with expectoration of a black colour resembling ink, and are affected with greater or less emaciation." In the thirty-five families studied, taken without any selection, Dr. Allison found that there were ten widows.

A little later, in 1851, Professor Bennett tried to sum up experience of lung disease among miners as it occurred in Scotland. He found that the disease was common in colliers, as in moulders of iron and copper : " yet it is curious that whilst it is common among the workmen of some coalpits it is unknown among these employed in others. For instance, it exists to a great extent among the colliers of Fife, Haddingtonshire, and Midlothian, but is unknown at Newcastle, Paisley or Alloa, although the dust and powder is as finely levigated in one place as in another." Bennett found that miners doing stone work in the pits were particularly liable to the condition.

Then and Now

These were the early gropings of a hundred years ago ; they showed among the physicians and industrialists of their day an interest in industrial health. We may ask, how do we stand now ? By comparison, I fear, not too well. We have still some enlightened employers ; we have, generally speaking, a level of social conscience among our people which we are unwilling to regard as falling short of that south of the Border ; we have still doctors interested in industrial health. But the traditional heavy industry of Scotland—and especially of Clydeside—is apt to be spartan in its outlook : employers and work-people alike have been bred in a hard school. It would be idle to pretend that Clydeside is accustomed to regard industrial health as a high priority ; and we welcome this visit, partly from its opportunity for professional counsel, partly as a stimulus to efforts worthy of our Scottish heritage.

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VICTUALS AND VENTILATION AND THE HEALTH AND EFFICIENCY OF SEAMEN

BY

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The importance of good victuals and sound methods for ventilating ships to the maintenance of health and efficiency of seamen is so well known that it may appear unnecessary to ask if the lessons and examples with which British naval history abounds are given the full consideration they merit in modern warship design and operation.

We are, however, at the dawn of a new age in naval development as in many other spheres of interest. In the same way as the coastal voyages of the slave-driven galleys of ancient times and the Middle Ages gave way, following the introduction of the mariners' compass by Prince Henry of Portugal, to the great navigations of the fifteenth, sixteenth, and seventeenth centuries and the maritime wars of the eighteenth ; so now may the steam and motor-driven vessels of the nineteenth and twentieth centuries to which we are accustomed be replaced by ships of new design, not only propelled at high speeds by new forms of power, but also greatly modified in structure because of the possibilities of future aerial, submarine, biological, and atomic warfare, and equipped to a high degree with complicated devices and weapons requiring skill, discrimination, and sustained concentration for their successful operation.

Future developments cannot fail to affect the naval way of life ; and enough has been seen in recent years of what can happen when the gadgeteer is allowed to run wild, to warn those responsible for the welfare and health of the men to keep a weather eye on plans for the future, and to ensure that the lessons of the past as well as those of the present are not neglected.

Historical Background

Until the reign of Henry VIII warships as such did not exist. Seaborne traffic was carried on by merchantmen, heavily armed, which were chartered by the King when he required them to carry his armies across the Channel for the wars with France. The sixteenth century, however, was one of great discovery. After Vasco da Gama's voyage to the East Indies in 1493, and after Cabot had sailed to Newfoundland from Bristol in 1496, the Merchant Adventurers' Company was set up in 1505. Magellan rounded Cape Horn in 1520 ; in 1530 William Hawkins sailed to Guinea and Brazil ; Richard Chancellor navigated the Northern Sea to visit Moscow in 1553 and founded the Muscovy Company ; in 1577–80 Drake circumnavigated the globe, and on December 31, 1600, the East India Company was formed.

Moore (1911) stresses the poor understanding of ship ventilation and the neglect of human requirements which undermined the health of the Fleet under Henry VIII, and he describes how, when Calais was lost in the time of Mary, the spread of disease contributed largely to the ineffectiveness of the British forces. Even the great naval battle of 1588 which resulted in the defeat of the Armada was fought by a British Fleet which was largely ravaged by epidemics. Letters from the Lord High Admiral, Howard of Effingham, to Burleigh and Walsingham continually stressed the need for replacing sick men and for providing money for clothes and other necessities for the crews who were in a parlous state after eight months at sea ; and they told also of the attempts made to defeat the scourge by cleaning out ballast, airing ships with fires, and renewing ships' companies. The winds scattered the enemy but the English losses from disease were desperately heavy.

Disease flourished particularly amongst the conscript motley of landsmen who were impressed in those days to serve in warships in times of national crisis. The tried and picked crews who signed on for special expeditions between the wars to sail under commanders such as Drake, who had care for the needs of their men, fared much better.

Indeed, had it not been so, voyages such as the circumnavigation of the globe by the *Pelican* (renamed the *Golden Hind* during the voyage) over a period of three years would have resulted in disaster. Even Drake had his troubles, however, and it is reported that he lost 600 out of 2,300 men from illness in ships which undertook an expedition under his command in 1585–86.

The decline of British seapower under the early Stuarts brought no amelioration to the lot of seamen. James I, described as " the most thoroughgoing Pacifist who ever bore rule in England," did little for them, and under Charles I warships were often little more than floating pest-houses. The high mortality amongst crews was repeatedly attributed by those in authority in the Fleet to poor and inadequate victuals, shortage of clothing, and appalling personal hygiene. Expedition after expedition failed because of the heavy toll of disease in ships' companies comprised largely of impressed landsmen who did not know how to live in ships and were unwilling to learn. This desperate state of affairs persisted, but not from lack of reports from commanders, whose suggestions for improvements were rarely implemented. For example, Captain John Smith (1626) in his " Accidence for Young Seamen " recommended in his " Petty Tally " an ample and varied diet including the " Juyce of Lemons for the Scurvey." It was, however, 150 years before this frequently advocated and provedly effective remedy became a general issue.

Under the Commonwealth, and with the influence of Blake, more human consideration was shown to sailors. An Admiralty Committee made recommendations concerning special provisions, landing of the sick, and the provision of old linen for dressing wounds. This considerate attitude appears to have continued in the Restoration period, and in 1665 the Navy apparently remained free from plague, owing to a wise policy of isolating the crews on board when many were dying ashore.

The Royal Navy was not created in name until the reign of Charles II, following the great victories of Blake, who insisted that the State ships should be designed and maintained primarily for battle purposes. For the next sixty or seventy years, however, the Fleet operated for the most part against the French, Dutch, and Spanish in the narrow waters of the English Channel, and naval warfare did not become a world-wide affair until the latter half of the eighteenth and the early nineteenth centuries, when lengthy blockades of the European ports kept the Fleet at sea for many months on end.

The severe conditions of the Napoleonic Wars brought home to the authorities the necessity for improving the lot of seamen and resulted in many reforms, which, blended with the introduction of steam propulsion and iron hulls during the comparatively peaceful Victorian era, led to the evolution of the standards of living and working conditions in warships as we find them today.

Scurvy

Scurvy appears to have been primarily a disease of comparatively modern times. Lind (1772), in a most comprehensive thesis, observes that although Hippocrates described an illness which was almost certainly scurvy, the succeeding Greek and Roman authors apparently did not know it. He attributed this to their scanty knowledge of northern waters and also to " their short coasting voyages," and these limitations applied to the experience of the majority of those that followed them for many years, although records are scarce.

With improved methods of navigation and the discovery of the Indies in the fifteenth century, the first recent account of this disease appeared in the chronicles of Vasco da Gama (1497), who lost a hundred men from his crew of 160 during his voyage around the Cape of Good Hope to the East Indies. Jacques Cartier, after his second voyage to the Saint Lawrence River in 1536, gave a vivid description of a disease which broke out amongst the garrison ashore which was probably scurvy and which responded rapidly to concoctions made from the leaves of a shrub (the hanneda) which was advocated as a remedy by the Indians.

The disease was not generally recognized, however, probably until long voyages away from land became more common, for the " incubation period " for scurvy appeared to be three to four months; thus the sea voyage of Columbus (1496) was completed well within this time, and they did not suffer from this disease.

Underwood (1947) points out that the relation of the lemon to the cure of conditions which were probably scorbutic was known from very early times, and refers to a monograph—*De Limonibus Tractatus*—extracted from the Arabic work of Ibn-al-Baitar (1197–1248) and translated into Latin by Andreas Alpagus which was published in Paris in 1602. It would appear that oranges and citrons were first introduced into England towards the end of the thirteenth century, but no references were made to their curative properties in treating scurvy before the end of the sixteenth century.

Underwood considered that Richard Hawkins of the *Daintie* in 1593 was the first commanding officer to plan to cure scurvy with oranges and lemons, which he procured on arrival at Santos in Brazil when bound for the Magellan Straits; James

Lancaster, in 1601, was the first to use lemon juice as a prophylactic; and Woodall (1617) was the first British ship's surgeon to extol the virtues of the lemon both in cure and prevention.

Lind abstracted the works of seventy writers of the sixteenth, seventeenth, and eighteenth centuries, who described the disease at first as an affection of armies and landsmen, although it was observed at an early time amongst the Dutch seamen. Then during the next two hundred years a succession of observers, in addition to those named above and including Don Sebastian Viscaino (1602), Drawitzs (1647), Cockburn (1696), Bachstrom (1734), MacBride and Desperierres (1767), and Jervey (1769), recounted the various virtues of fresh vegetables, fruit juices, and vegetable brews and broths in the cure and prevention of scurvy as a disease of seamen.

Other pioneers in the use of fruit juice and extracts as anti-scorbutics, although not specifically for diseases of seamen, were Peter Forrest (1595) who made a syrup from scurvy grass, and Solomon Albery (1593), Felix Plater (1608), and Francis de la Böe (1674) the famous Leyden Professor, who all advocated the use of oranges.

Shore-side medical men were inclined to discount the effects of scurvy in ships and to attribute the poor state of health of the seamen largely to the professional incompetence of the sea surgeons and physicians, and in 1685 Sydenham went so far as to say "the two great subterfuges of ignorant physicians were malignity and the scurvy, which they blamed for disorders and symptoms often owing to their own ill management." Undoubtedly, the views of such eminent authorities went far to cause adverse decisions by the Admiralty when they were petitioned for a more wholesome diet, for the naval service was not popular with the medical profession at the time, and in 1692 the Barber-Surgeons' Company asked for a standing authority from the Lord High Admiral to impress surgeons and surgeons' mates.

Between 1708 and 1711 there took place the three-year voyage round the world of the *Duke* and the *Dutchess*. The famous Dr. Dover sailed in the *Duke*, but despite his presence and the boast of her Captain, Woodes-Rogers (1712), that the means for preventing scurvy were well known, they buried the first man with scurvy on Jan. 1, 1709, having sailed the previous August.

The ravages that occurred when the antiscorbutics were neglected on long voyages were also well illustrated by the experience of Anson (1740–44) on his voyage round the world. By the time he reached Juan Fernandes, two of his ships, the *Gloucester* and the *Centurion*, had lost respectively three-quarters and three-fifths of their ships' companies, whilst the majority of the survivors recovered with the fresh provender they obtained ashore. This disaster provoked fresh enquiry into factors affecting the health of seamen, stimulated scientifically-minded men to explore the possibilities of ventilating warships, and probably caused Lind to intensify his study of preventive medicine which preceded the first publication of his Treatise in 1754.

Despite the ample evidence available in his elaborate review of literature and from his own personal experience, Dr. Lind attributed the disease to "First, an intense degree of cold . . ." and then to other causes "such as indolence, close confinement, or a sedentary and inactive life," and he suggested exercise as a preventive measure; but nevertheless he freely discussed the value of fresh vegetables, scurvy grass, cresses, and lemon juice, and finally recommended the acids "in oranges, and most ripening sub acid fruits as the most effectual preservatives against this distemper."

Perhaps Lind, a Naval physician, was to some extent influenced in summarizing the requirements for dealing with this condition by the politics and prejudices of the day. Certainly his conclusions are less forthright than the clearly expressed opinions of Bachstrom and Jervey, and later of Trotter and Blane, and in the early part of his book he seems inclined to discount the primary value of green vegetables.

He was very well aware of the value of Hales' ventilators for maintaining health, and he stressed the importance of ventilating regularly and the beneficial effects of the exercise thus induced. He also urged frequent bathing for ships' companies, but—correctly—did not associate these latter factors with the ætiology of scurvy, unlike certain others at that time.

The attention of the Service and of scientific men was by now drawn to the essential facts, and wise commanders employed every resource to husband man-power on their long voyages. In 1776 Captain James Cook was awarded the Copley Gold Medal of the Royal Society when he described how he accomplished a voyage in the *Resolution* of three years eighteen days, through all climates from 52° North to 71° South, with the loss of one man only by disease, ". . . who died . . . without any mixture of scurvy." Each man received daily one, two, or three pints of sweet wort "doubtless one of the best antiscorbutic sea medicines," and twice a week a pound of "sour krout," whilst the surgeon found vegetable soup, lemons, and oranges "useful." "The crew were at three watches . . . and proper methods were employed to keep their persons, hammocks, bedding, clothes and etc., constantly clean and dry." Equal pains were taken to keep

the ship clean and dry ; " and once or twice a week she was aired with fires," and " had also frequently a fire made in an iron pot at the bottom of the well, which greatly purified the air . . . To this and cleanliness, as well in the ship as in the people, too great attention cannot be paid."

Cook believed primarily in cleanliness and ample fresh water : " I am convinced that with plenty of fresh water, and a close attention to cleanliness, a ship's company will seldom be much afflicted with scurvy, though they should *not* be provided with any of the antiscorbutics . . . , " but he used them assiduously all the same, and valued a mixed and fresh diet highly ; " we came to few places where the art of man or nature did not afford some sort of refreshment or other, either of the animal or vegetable kind. It was my first care to procure what could be met with of either by every means in my power, . . . and to oblige my people to make use of them both by example and by authority."

He spoke highly of the constant help he received from his physician, William Anderson, both in caring for the wants of the men and also as a skilled naturalist (Keevil, 1933). They were constant companions on explorations ashore, and there is little doubt that Anderson's early death at the age of 30 years cut short a career of great scientific promise, either as a naval physician or as a biologist. His contribution to the achievement of the *Resolution* was certainly of major importance.

The Ventilation of Sailing Ships

Even in Elizabethan times Sir Walter Raleigh commented on the evils of poorly-ventilated spaces : " Cabins are but sluttish dens that breed sickness . . . " (Shaw, 1929). From the time of the Tudors onwards the necessity for ventilating ships became increasingly apparent, as the open ships and single deckers gave place to three deckers and larger ships, in which men slept well away from the upper deck and lacked fresh air, especially when the gun ports were closed because of rough or cold weather.

Shaw gives a grim summary of conditions prevailing in ships during the eighteenth century : " Besides overcrowding and deficient ventilation . . . the ships were damp, bilge water was often foul and its odour penetrated the whole ship. The men . . . frequently were without changes of clothing ; washing facilities were meagre, due to not only the very restricted water supply, but also the lack of soap ; and the numerous candles used for lighting purposes further contaminated the air . . . live stock were frequently accommodated on board . . . " Rotting ballast further fouled the atmosphere. Vinegar was widely used to purify the air, and was wrongly thought to prevent the spread of infection. Ships' companies were diluted with the unhealthy scourings of the seaboard towns who were " impressed " to serve in the Navy by the press gangs.

Although the physical nature of the convective effects of the fires between decks was incompletely understood, their value was well appreciated in the seventeenth and eighteenth centuries not only for preserving the health of the men, but also for saving the timbers of the ships. The latter requirement possibly carried a higher priority than the former in arousing the keen interest shown in warship ventilation. Desaguliers (1727, 1735 ; quoted by Reid, 1844, Bernan, 1845, and MacDonald, 1881) was consulted by the Admiralty about 1740 as to whether " the centrifugal wheel and pipes " with which he had ventilated the House of Commons a few years earlier might be used to purify the air of ships ; and at the same time Dr. Stephen Hales (1755) conceived a method of utilizing ventilators for the same purpose, which were worked by hand and had a bellows-like action. He described his invention to the Royal Society in May, 1741.

These devices, however, required men to work them constantly (these men were called the " ventilators " by Desaguliers, who called his machine a " blowing wheel "), and a more subtle solution was proposed by a brewer called Samuel Sutton (1744). He proposed to lead pipes from the hold or from other foul spaces below decks into the enclosed galley fire places beneath the coppers in which provisions were boiled ; thus making use of the convective currents induced by the fire in place of the human operators. After trials ashore this economical system was installed in the *Norwich* in 1741, which then sailed on a tropical cruise for two years. On his return the Commanding Officer reported indifferently on the method, notwithstanding the sustained good health of his crew, which he attributed to the ship making enough water to " keep her sweet," presumably by flushing the bilges. However, Sutton's pipes were subsequently fitted in the *Namur*, *Warwick*, *Sandwich*, and *Vigilant*, and were received more favourably.

In the meantime Hales' ventilators were fitted into the ships of the slaving trade. It was remarked that the exercise of " ventilating " kept the slaves healthy, and the valuable cargo was excellently preserved by the improved air below decks, so that the survival rate of slaves was said to be increased by as many as twelve times following the fitting of ventilators in five Nova Scotia slavers in 1749.

Apparently ventilators were fitted in warships as well, for in a further communication to the Royal Society in 1755 Hales quoted the experience of Captain Thomson of the *Success* frigate in 1749 : " Their rule for ventilating was half an hour every

four hours but, when . . . neglected for eight hours altogether then they would perceive, especially in hot weather, a very sensible difference by that short neglect of it . . . There were two hundred men on board for almost a year yet he landed them all well in Georgia," and again " . . . the crew of this ship, which lay windbound for four months with the expedition Fleet which soon after invaded France, were very healthy all the time, when they were very sickly in all the ships of that expedition," a naturally controlled experiment.

Later Hales' ventilators were fitted at Haslar Hospital, and in other shore establishments, and in 1756 they were installed in the *Royal George*, " In which the Honourable Admiral Boscawen, taking care to have them properly worked, they were found to have the desired good effect, so to refresh the whole air in the ship as to preserve in good health 850 people ; which happy event occasioned their being ordered to be put into the whole Fleet." (Hales, 1758.)

It transpired, however, that although the inventions of Hales and Sutton were both proved in practice, they were frequently improperly used or not used at all, and before very long the old-fashioned windsails, always at the mercy of contrary winds, regained their place as the main standby for warship ventilation, and retained it for the next hundred years or so, coupled at times with the use of fires between decks to " dry the air."

The lively spirit of invention and rivalry in securing improved conditions for men in ships was occasioned firstly because the country was fighting naval wars for much of this century, and the Admirals, if not the Government, realized that men were the first machines of war, and that the country was going to run short of seamen if energetic measures were not taken to preserve their health, and, secondly, because the human cargoes to be carried from the Guinea Coast to the American plantations were of great commercial value. It paid to land slaves in good condition. But, although these incentives continued for some time, no notable progress was to be made in methods of ventilating ships until in place of men, steam and electrical power became available to work the fans.

The Rise of Naval Preventive Medicine

The greatly improved health of the Fleet towards the close of the century was discussed in the Despatches and Letters of Lord Nelson and in the writings of Gilbert Blane. In 1781 the latter reported from the West Indies that in one year, out of 12,109 seamen in twenty sail of the line, 715 died on board, 862 died in hospital (a death rate of 1 in 7), and 350 were invalided, whilst only twenty-four years later Nelson declared that during two years in the Mediterranean (1803–05), from amongst six to eight thousand men in ten to twelve ships of the line and three frigates under his Command, only one hundred and ten died (a death rate of 1 in 127), 141 were sent to hospital, and the average number sick was only eighteen to a ship.

The great attention paid by Lord Nelson to the health and morale of his men is repeatedly shown in his letters and despatches (Laughton, 1866 ; quoted by Turnbull, 1904). Thus in August, 1803, he wrote to Dr. Baird : " The last ships out, although they came to sea wretches, are generally speaking in the most healthy condition ; they are in the best humour which is a great conducer to health." And again on Nov. 1, 1803, at Madelena : " . . . now upwards of five months at sea. But our health and good humour is perfection, and we only want the French Fleet out . . . " ; and on March 11, 1804 to Dr. Moseley : " The great thing in all military service is health, and you will agree with me that it is easier for an officer to keep men healthy, than for a physician to cure them." In the same letter he showed his anxiety to keep the minds of the men active during periods of waiting : " . . . yet I have, by changing the cruising ground not allowed the sameness of prospect to satiate the mind . . . " Lastly he warns against false economy in a letter to Dr. Baird on March 18, 1804 : " . . . Bear in mind not to be penny wise pound foolish. A small sum well laid out will keep the Fleets healthy, but it requires large sums to make a sickly Fleet healthy. Health cannot be dearly bought at any price, if the Fleet is never sickly."

The improved health of the men in Nelson's blockading Fleet was attributed to the following causes by Leonard Gillespie, Physician to the Fleet at the time :

1. Good victualling. Good quality wine, fresh meat and vegetables.
2. Avoidance of wet decks. The ample use of stoves and ventilation.
3. The constant activity and motion in which the Fleet was preserved. They were always at sea, never idle, and there was no time for intemperance ashore.
4. Promotion of cheerfulness by music, dancing, and theatricals.
5. Great attention to the care of the sick.
6. The issue of Peruvian bark (cinchona) mixed with wine and spirits to men employed in " wooding and watering."

A consideration of these fundamental concepts, which the old Admirals put into effect, leads one to wonder how far the Navy has advanced since the general introduction of lime juice in 1795. Although a vast array of mechanical devices are now to hand,

with power to drive them, and great advances have been made in the control of infectious disease, we would do well to consider if the importance of the human factor is rated as highly now as it was at times in the past, when the difficulties to surmount were vastly greater.

The great debt owed by the Navy to Lind, Trotter, and Blane as the founders of naval hygiene is well outlined in an anonymous review in the United States Naval Medical Bulletin (1920), which describes how they struggled against "stupidity, ignorance, prejudice, and indifference in high places and low, in the Admiralty and the forecastle; they had the hard task of seeking to break down immemorial custom; dared to challenge tradition; . . . and preached seemingly frivolous beneficent novelties to insular conservatism that held hardship essential for hardihood."

The part played by their varying personalities in the success they achieved is well shown: Blane, tactful, patient, and well-connected, and from the start the close friend of captains and admirals; Lind, the pioneer, a genius for observation and deduction, a diligent student and a careful writer, but disappointed by failure to achieve in his time the full credit he deserved; Trotter, a man of great energy as well as learning, had more sea service than either of the others and insisted on the need for sea surgeons and physicians to learn the problems of the Service by going to sea before they were given high places in the service of the Admiralty. He was a keen practical observer and appears to have had the good will both of sea surgeons and physicians and of medical scientists, such as Jenner, whom he greatly admired; but he was in constant rebellion against what he considered to be the intransigent attitude of the Admiralty.

Lind speaks of "the preposterous custom of washing decks after sunset," and stresses the need for keeping ships dry. The idea that it was necessary to soak wood to season it before ships were built meant that the timbers of many ships were rotten before they were launched and men-of-war rarely lasted for more than seven or eight years without complete overhaul. He considered the damp timbers to contribute greatly to sickness and pronounced Hales' ventilation system "the most beneficent invention for mariners which this age has produced."

Trotter (1797) probably provided the best review of the practical situation in ships and he wrote extensively of the evils of impressment, which he pronounced to be "the cause of more destruction to the health and lives of our seamen that all other causes put together." He strongly supported the arguments put forward by Lind and Blane for a general uniform to be issued to seamen, and expanded on the need for good ventilation, suggesting that "more attention be directed to the construction of pumps for dislodging a vitiated portion (of air), than has been bestowed on a machine that should fill up the vacuum by a purer column (of air)." He referred to the inconvenience of using scuttles and ports for ventilation purposes and the shortcomings of wind sails, and suggested the construction of "air flews" communicating with the upper deck and the compartments below. He gave, in fact, a nice account of the ends which warship ventilation should achieve.

Blane, in a foreword to his "Diseases of Seamen" (1799), says that when he joined Admiral Rodney's Fleet in 1780 the Admiral instructed him that every surgeon was to send him a monthly return, "stating the degree of prevalence of different diseases, the mortality, and whatever else related to the health of the prospective ships." This wise instruction enabled Blane to collect a wealth of information about the health of the Fleet then and in the succeeding years, and these nosological returns became the yardstick by which he measured the improved health of the Navy during the wars with France. He showed that the yearly proportion of those sent to hospital in all parts of the world to the number voted by Parliament for the Navy only changed from 1 in 3·3 to 1 in 4 between the years 1782 and 1795, but had fallen to 1 in 10·75 by 1813. This remarkable change was ascribed to the general measures discussed above and to the general issue of lime juice after 1795. There was little change in health during the next sixteen years, and in 1829 the above ratio rose to one in 8·9, due to the increase of yellow fever in the Fleets.

He contrasted the experience of Lord St. Vincent—who in 1800 blockaded Brest with twenty-four ships of the line for four months without one of them being in port, and without sending more than sixteen men to hospital—with the experience of the Channel Fleet during the American War, which sent 6,064 men to hospital in a four-month period with fever and scurvy, and 2,500 on another occasion after a ten-weeks' cruise. In the first five years of the war with France the numbers of men admitted to the Hospitals at Plymouth and Haslar were 27,000 less than in the first five years of the American War, although there were more ships in the Fleet.

This was a further instance of the "good that cometh out of evil." Health at sea prospered under the conditions of war, when the wits of the commanders and surgeons alike were sharpened to husband all resources, although the conditions of service were hard indeed and long dreary periods were spent at sea. Blane states: "One of the

most distinguished sea officers that ever lived declared to me, that it was his conviction that two ships now are equal to four of former times." At the same time there was still room for improvement. In the good year of 1813 he assessed the mortality in the Navy to be 1 in 42 (24/1,000), or double the mortality for subjects of the same age in civil life on shore, greater even than the mortality amongst prisoners of war, and more than twenty times the average mortality in the modern Navy. He estimated that but for the advances made in preventive medicine the whole stock of seamen in England would have been exhausted before the conclusion of the Revolutionary War (1793–1815), and there seems little reason to doubt his logic.

Blane summarized the main measures by which this remarkable change was achieved as follows :

> " The scurvy has been prevented, subdued, and totally routed out by the general use of lemon juice, supplied for the first time at the public expense in the year 1795 . . . fevers have been extinguished (though not so rapidly as scurvy) by watchful attention to the following points ; cleanliness, ventilation, dryness, sobriety, the separation of those in health from those affected with contagious fevers, and by a more general and deep impression on the minds of Commanding Officers, that one of their most sacred and indispensable duties consists in enforcing the means of preserving health, and that to them, more than the medical officers, belongs the duty of an unremitting vigilance with regard to all these regulations as points of discipline, now so well ascertained, by which the generation and the spreading of infection are counteracted."

He also considered the improved methods of recruitment and the reduction in the number of Press Gangs to be important contributory factors to improved health and morale, by eliminating many unsuitable and unhealthy men from the ships.

Blane did not lay over-great stress on ventilation, and he referred to the sheathing of ships with copper to preserve the timbers, which thus reduced one of the eighteenth-century needs for good ventilation. He claimed considerable credit for the general issue of lemon juice and soap to the Fleet, and stressed the part played by the better health of the British seamen, in comparison with that of the Frenchmen, in securing victories in sea fighting at close quarters ; and he postulated the important role of the Medical Officer in promoting fighting efficiency. He also observed : " Success in battle is one of the best general tonics for health."

Trotter (1797), and Gillespie (1798) did emphasize the importance of securing good ventilation and dryness by the frequent use of fires between decks and by rigging windsails, and also of personal cleanliness, wholesome clothing, thorough airing of hammocks and bedding, frequent baths in tubs or over the side, and the need for keeping men mentally occupied and in a happy frame of mind.

Gillespie directed attention to the need for reducing complements in tropical waters, and suggested an automatic reduction of one sixth of all ships' companies. Trotter insisted on the rigid isolation of the sick after cleansing to prevent the spread of disease, the routine inspection of men on joining the ship, and the importance of executive officers realizing their responsibility in the field of preventive medicine. He remarked : " . . . nothing seems more extraordinary than the general neglect there is of working the fixed ventilators. They should never stand still for a moment" ; and finally : " It has been wisely said that the fatherly care of a Commander is the Seaman's best physician."

The teachings of these naval doctors were hammered home later in the Instructions for the Physicians of His Majesty's Fleet (1825), where the use of hanging stoves for ventilating between decks and in the well was recommended, and it was laid down that " dryness, cleanliness and ventilation are the most effectual means to prevent diseases and contagion," and physicians were required to transmit to the Victualling Board at regular intervals :

1. Nosological returns of the state of the sick.
2. State of the weather and climate.
3. Height of the thermometer.
4. Any other circumstances influencing health.

There now began a period of peace which lasted many years. Such wars as there were mainly served as manœuvres for the Navy, which was busily occupied converting the wooden sailing ships into iron battleships driven by steam.

The standard publication of the Health of the Navy was commenced in 1840, when Wilson covered the years 1830–1836, at the direction of Sir William Burnett, and thus carried on the good work started by Blane at the injunction of Admiral Rodney. In his introduction details of victualling and of issues of spirits and lime juice are described which appear reasonable in the light of the times, and instructions for securing a healthy water supply and certain other standards are laid down. The usual space between the clews for hammocks was to be 14 to 18 inches, so that, " when they are extended by the beds, their bodies are in contact." Dry stoning the decks instead of wet washing was advised, and personal cleanliness was stressed. The influence of a happy and trained mind on health was also noted. Schoolmasters (instructors) were borne in ships after 1837, and ships' libraries were established in 1838 by Admiralty Orders.

The one field where little advance was made was

that of ventilation. Windsails, although admittedly defective, were still the main standby, and Wilson states: "Though other methods have been proposed, they have either not answered, or have not yet been sufficiently tested to show their effectiveness"; but he throws out a hope that an air pump designed by a Captain Warrington might soon be available by which pure air might be transmitted "through tubes led along the sides of ships." Thus it would seem that Hales, Sutton, and Desaguliers had been forgotten for the time being.

Since this time the Health of the Navy has been published annually and only discontinued in time of war. Thus we have no health records of the 1914–18 War after 1915, nor are records available for the latter part of the 1939–45 War, apart from those relating to invalidings and deaths, with the exception of certain limited information concerning health in the Eastern and Pacific Fleets in 1944 and 1945 (Ellis, 1947, 1948).

The Ventilation of Steam Ships

Interest in warship ventilation was aroused afresh in the middle of the nineteenth century by the need for equipping three ships which were to go on an expedition to the Niger River to abolish slavery (M'William, 1843). The farsighted Dr. Reid (1844) had advised on the methods of ventilating the ships by means of a power-driven "fanner," which was operated by kroomen when steam was not available, and was devised so that the entire air supply was drawn through a chlorinated filter, by which the intention was to purify it. The resistance of the filter obviously limited the input of air and led to differences of opinion between the medical officers of the different ships. One preferred to dispense with the filter and have a better air supply; the other considered better results were achieved with the filter in use. The expedition failed, but not apparently because of the heat, for the men remained fit in the tropics until they reached country which was heavily ridden with mosquitoes and fever.

Dr. Reid lays down interesting standards in his book on ventilation published after this expedition failed. He considered that for an uncrowded compartment, at an average temperature, air should be provided at a rate of ten cubic feet per person per minute, but he noted that considerable increases were required when numbers were high or if the air was heated; and stated that 100 cubic feet of air per man per minute might be less powerful in the tropics than one cubic foot of air in cold countries "in its power of absorbing moisture from the body."

He remarked on "the very different effects produced by the same atmosphere at the same temperature according to the rates at which it moves," and considered that "in England for men engaged in bodily work a temperature of 65° F., with an atmosphere moving in a very gentle stream, so as not to be perceptible unless very marked attention be paid to it, is the most generally agreeable in rooms which are not overcrowded." This view, recorded over one hundred years ago, and the importance attached to the significance of air movement and of a varying moisture content of the air, accord closely with those held today (Bedford, 1946). Again one can only remark that, although mechanical devices have become increasingly ingenious and steam and electric power have been harnessed to a high degree of efficiency, the desirable qualities for the thermal environment in which men should live and work were known long ago and have altered little, but the provision made to satisfy these criteria frequently fails dismally.

Reid placed windsails in the correct perspective as valuable auxiliary aids to inadequate ventilation; he recommended the use of the convection currents created by the galley fire or by other fires as further ancillary aids; and he proposed the adoption of exhaust ventilation, to be obtained by power-driven fans, which would exhaust the air from the compartments through ventilation trunking distributed throughout the ships. He observed that this system could be converted to a plenum system by reversing the direction of the fans. Modern warship ventilation can be said to have evolved from this time onwards.

In the remainder of the nineteenth century, apart from minor mechanical developments, few new concepts were introduced which bear upon the matters under discussion. Various enthusiasts tried to solve the problems of ventilating ships by devices such as Arnott's Ventilating Pump or Edmond's "Steam Exhaust" system—which utilized the steam jet from the boilers—whilst others tried to use the draught of the funnel uptakes. In 1867 mechanical ventilating fans were installed in the *Hercules*, and in 1873 steam-driven fans were fitted in the *Devastation*, but MacDonald in his book on Naval Hygiene in 1881 still laid great emphasis on the value of windsails, natural plenum ventilation with uptake cowls and shafts, and numerous ports and scuttles; and artificial ventilation by centrifugal fans was still considered to be generally unpractical. Handworked Desaguliers' fans were, however, sometimes employed for magazine ventilation.

Methods of gas analysis were now used to assess the effectiveness of ventilation systems, and six volumes of carbon dioxide per ten thousand parts of air in compartments was considered to be the upper desirable limit for warships (normal CO_2

content of air 4 per 10,000). It was calculated that a supply of three thousand cubic feet of air per person per hour would be necessary to comply with this standard, and thermal considerations were only of secondary importance.

The replacement of the wooden ships by steel battleships meant a sacrifice of the excellent insulating properties which the wood afforded against severe climatic conditions, to keep the ships cool in the tropics and warm in northern waters. The wooden upper deck was, however, retained, and where it is fitted it is still one of the most effective counter-measures against excessive solar radiation.

The use of portable handworked fans and air hoses for ventilating the double bottoms of iron ships throughout the time when men were working in them was stressed in the current Queen's Regulations and Admiralty Instructions, for the danger of entering unventilated confined spaces was generally known after a widely publicized but non-fatal accident in the pump well of the *Minden* in the year 1819, and the " lighted candle test " was advocated on the occasions when such spaces were opened.

Naval warfare remained a placid affair for the remainder of the century, and in the Queen's Regulations and Admiralty Instructions (1899), the injunctions of Cook and Nelson a century or more earlier were re-echoed :

" 1. The Captain will use his best endeavours to ensure cleanliness, dryness, and good ventilation throughout the ship, that all compartments are kept dry . . . He is to take every possible means to ensure a thorough natural circulation of air through the ship at all times . . .

4. If the weather should prevent the ports from being opened for a considerable time fires are to be lighted in the stoves, and windsails are to be freely used.

5. He is to see that the men are properly clothed."

Electrically driven ventilation fans were installed at the beginning of the twentieth century in the *Hogue* Class Cruisers and the *Canopus* Class Battleships. The principle of " single compartment ventilation " was accepted, and in 1903 steam heating of the air supply was introduced to reduce icy draughts on the mess decks.

The Admiralty Ventilation Committees of 1912 and 1937

In 1912 Their Lordships convened an Admiralty Ventilation Committee, of which Professor J. S. Haldane, F.R.S., was a member. This committee presented its Report in 1914, after conducting a thorough investigation of ship conditions and numerous practical experiments. They recommended *inter alia* :

1. An air temperature of 55 to 60° F. for compartments in cold weather, and a somewhat higher temperature for hot weather.

2. That ventilation should be such that in the hot engine rooms and auxiliary machinery spaces a rise of temperature exceeding 30° F. above that of the outside air should be prevented at places where men may have to stay for some time, and that " when the wet-bulb temperature exceeds 85° F., it may be necessary to carry out relief at short intervals."

3. That the plenum system should be adopted before the exhaust system in living spaces.

4. That the proportion of carbon dioxide in the atmosphere should be kept below 7 volumes per 10,000 volumes of air by adequate ventilation, which should be of the order of 3,000 cubic feet per man per hour (50 cubic feet per man per minute).

5. That a space of 200 cubic feet per man should be provided in messing spaces, and that the spacing between the hammocks should not be less than 20 inches.

6. That the air supplied through the ventilation trunking should be warmed by " indirect " heating for use in cold climates.

Special recommendations were made to cover the control of " wild heat " by fitting adequate insulation to prevent the emission of heat radiation from hot bulkheads heated by the sun or by machinery, from hot steam pipes, from the machinery itself, and from hot exhaust ventilation trunks and funnel uptakes. These were factors with which Nelson did not have to contend, and with the added factors of increasing compartmentation and watertight subdivision of ships marine ventilation was becoming a most complicated problem.

The recommendations of the Committee were put into practice in the 1914–1918 War, which was fought mainly in temperate and northern waters where the warmth of ships' companies was an important consideration, and the dirty evolution of " coaling ship " added to the hygienist's worries.

Following the declaration of peace there were few changes for several years. Dudley (1928) called attention to the high temperatures recorded in the tropics even in peacetime in *H.M.S. Dunedin*, and, together with Shaw (1928), reiterated Dr. Reid's emphatic statement of eighty years previously at the start of the " steam-age," that adequate air movement was essential to the comfort and well-being of men below decks in the tropics. He made a strong plea for adequate supplies of fans for circulating the air within compartments as well as for supplying air to them.

Shaw in his book on naval hygiene (1929) showed the importance of medical statistics in evaluating the results of preventive medicine, and divided his subject into " individual hygiene," which by then had reached a high standard, and " environmental

hygiene," which was limited by the rigid considerations of warships where space was at a premium and also by the practical limitations to defining optimum thermal conditions below decks for ships which must operate all over the world. Ventilation was still designed to limit undesirable accumulations of carbon dioxide rather than with the aim of controlling the thermal environment, but he drew attention to the methods for assessing the thermal conditions which were most suitable for employment in ships, and described the sling hygrometer, the unsilvered dry and wet kata thermometers (cooling range 100 to 95° F.), and the vane anemometer. He recommended 62° F. as the optimum temperature for living spaces.

In 1937 the Admiralty convened another Ventilation Committee, which was directed primarily to consider the problems of magazine ventilation and the potential hazard of carbon monoxide poisoning following underwater explosions. Sir Leonard Hill, F.R.S., served as a member on this Committee.

As far as the living and working conditions of the men were concerned they accepted standards which fell below those of the Committee of 1912 in certain respects. These decisions were necessitated by the considerable increases in ships' complements and equipment which were necessary to keep pace with the rapid advances in methods of making war, and were aided by the establishment of new criteria for defining efficient compartment ventilation. These required that the chemical standard hitherto employed, which aimed at controlling the level of carbon dioxide in the air, should be replaced by a thermal standard, which aimed at the control of compartment warmth rather than the chemical purity of the air.

It appeared likely that the adoption of the new standard would lead to certain difficulties. The range of environmental conditions encountered in any ship varies widely, and it was appreciated that the fresh air requirements of the various compartments would vary greatly, not only from compartment to compartment but also in the different parts of the world. It was planned to meet the former difficulty by varying the size and power of the fans supplying air to and exhausting air from compartments, and to cope with the latter by installing " two- or three-speed " fans as a general rule. The correct operation of the ventilation system to meet the needs of the men now needed considerable skill and thought from the ships' officers, and the maintenance of numerous fans and great lengths of ventilation trunking threw heavy additional burdens on ships' electrical and engineering staffs.

The quantity of air to be supplied to the messdecks was reduced from 3,000 cubic feet per man per hour (50 cubic feet per minute) to 2,000 cubic feet (33 cubic feet per minute) if possible, and to a minimum of 1,500 cubic feet (25 cubic feet per minute). The number of air changes per hour per compartment was allowed to vary from 60 in engine rooms to 6 on the messdecks, or 3 in lobbies which were not continuously occupied. Thus, although ships were becoming more crowded and warmer, a reduction in ventilation of the living spaces was at times accepted.

This Committee found that the existing practice in ships only allowed on an average 120 cubic feet of space to accommodate a man on a messdeck, with an average space of 18 to 20 inches between the clews (suspension points) of hammocks. As it was desirable to keep at least three feet between the heads of men, in order to prevent airborne spread of infectious diseases, they recommended that ratings should sling alternately head to foot. It was appreciated that this did not conform with the most desirable standards of barrack hygiene.

They recommended an air temperature of 60 to 65° F., for cold climates, the general adoption of high velocity ventilation terminals, and the continuation of heated air supplies for northern waters, but considered that air-conditioning of compartments was not essential in a warship. The problems of tropical warfare were not considered in any detail.

The last observation of historical importance was made by Forbes-Guild (1940), just before the outbreak of the 1939–45 war, in a sloop in the Persian Gulf. He showed the value and limitations of a portable air-conditioning plant, obtained locally and not designed for shipboard use, not only in improving the living and working conditions, but also in treating and averting cases of heat stroke and heat exhaustion which are not uncommonly encountered in that excessively hot part of the world.

The Results of Naval Preventive Medicine

Shaw (1929) was able to show remarkable improvements in the Navy since the Annual Health Report was instituted in 1856. These were largely due to the influence of preventive medicine. Thus the average death rate per thousand men of the total force fell from 14·34 in the years 1856–60 to 4·87 for 1881–90, then to 2·47 during 1911–15, and finally to 1·4 for the year 1926. The average daily number sick per thousand men fell from 53·6 for the period 1856–60, to 31·8 for 1900–09, and to 20·45 in 1926. The final invaliding rate fell from 18·12 per thousand for 1900–09 to 12·9 in 1914, rose to 24 in 1915, owing to the call-up of the unfit, and remained at the relatively high level of 18·12 in 1926,

this possibly being due to the greater discrimination shown by that time in eliminating unhealthy men from the Service.

As instances of the way in which preventive medicine improved naval health, Shaw mentioned the reduced incidence of enteric diseases from 2·07 per thousand (1900–09) to 0·11 in 1926, the rarity of undulant fever—the one-time menace to the Mediterranean Fleet—and the virtual elimination of scurvy, small-pox, typhus, and yellow fever from the naval community, although he indicated tuberculosis, pneumonia, diphtheria, and venereal disease as illnesses requiring, at that time, further measures to secure their prevention.

In connexion with the above figures it is of interest to consider the annual rates for invalidings and deaths between the years 1934 and 1943, which show that before and during the early years of the war the death rate was 1·1 per thousand, an improvement on the figures considered hitherto and less than one twentieth of the rate in 1813.

Conclusion

When Great Britain declared war in 1939 the Royal Navy had not for over 130 years conducted major fleet operations which involved ships remaining continuously at sea in the " battle state " in tropical waters.

During this time the environment of the sailor had changed greatly. Wooden sailing ships, largely at the mercy of the wind, had been replaced by steel coal-burning or motor-driven vessels. The main causes of man-power wastage in the past—dietary defects, which produced scurvy and other deficiency diseases, and poor ventilation and a low standard of preventive medicine, which allowed the rapid spread of infectious disease on the messdecks—had been corrected to a very large degree; but the thermal environment below decks, despite the advances in ventilation, was probably more severe than in Nelson's wooden ships, for Blane (1830), in his careful summary of the factors contributing to naval ill health, does not even refer to the adverse effects of excessive warmth.

Furthermore, ships' companies nowadays live " in " ships, not " on " them as was more customary in sailing ships, except perhaps in the tropics where the warmth below decks may drive many up on deck if air-conditioning of living and working spaces is not available.

A first-class knowledge of seamanship is an essential attribute of only a limited proportion of the men who now decide to make the sea their career, and the importance previously focused on the seamen now applies equally to men working in machinery spaces and in wireless or radar offices, to those manning gunnery control positions or fighter direction offices, or to those maintaining aircraft in the hangars of carriers. Other men are required for highly responsible and technical duties in submarines. The demands for skill, judgment, good powers of concentration, initiative, and ability to make rapid decisions, frequently exceed the former primary requirement for hardiness or toughness in a member of a warship's complement.

The conflicting needs for equipping ships with increasing numbers of weapons and technical devices and augmenting their crews with additional men to operate and maintain them, and for providing the crews with optimal environmental conditions to enable them to use the equipment efficiently, impose difficult decisions on the naval staff who lay down the requirements which the naval constructors try to meet in designing new ships.

Ideally, these staff requirements should specify the optimum thermal conditions which should be achieved under different external conditions, should lay down the space required for each man on the messdeck, and should state the amounts of fresh air which should be supplied to occupied compartments under different conditions to ensure the maintenance of satisfactory air hygiene with normal occupation; but the indefinite nature of scientific knowledge relating to such factors as these, especially with reference to extreme climatic conditions, has led in the past to guarded or incorrect statements from medical men when they have been taxed by the staff to make positive recommendations.

We need to know more about many of these environmental factors, and within recent years much research outside the scope of the present review has been put in hand to fill some of the more pressing gaps in our knowledge, for the war with Japan showed strikingly how little our ideas had changed since Dr. Reid advised the Admiralty a hundred years ago on the fundamental principles to follow in designing ventilation systems for warships in the tropics.

A century's progress in the art of ventilation engineering, and the large-scale development of methods for cooling and dehumidifying air supplies in the twentieth century, have placed at our disposal the means for providing the occupants of warships in the tropics with thermal conditions compatible with the full maintenance of health and efficiency, provided the physiologists will define clearly the conditions which the designers must meet. In the same way optimal conditions may also be achieved below decks under arctic conditions by the application of modern methods of radiant heating or

heated air supplies, but again the physiologists must state clearly the desirable conditions under which men should live in these extreme climates.

It is not intended to refer in detail here to the conditions which were encountered in warships in the 1939–45 War, to which recent references have been made elsewhere (Critchley, 1945 ; Ellis, 1947, 1948) ; nor will space allow the examination of more than a small part of the evidence available in the chronicles of naval medicine, and of the voyages of the past.

It will be seen, however, that in the past disease in the Fleet always rose to a peak when large numbers of landsmen were impressed in times of crisis, and declined when the landsmen had learned to become seamen under the conditions of war. This period of learning frequently coincided with a heavy manpower wastage from preventable disease and malnutrition, and an increasing realization on the part of commanders that if they were to maintain a healthy and efficient fighting force they must ensure reasonable standards of air hygiene and must feed and clothe the men adequately. These points are well illustrated by the events of the Elizabethan and Napoleonic Wars, and towards the end of the latter it was confidently stated that, despite the fact that the French had designed more efficient fighting ships, the British sailors enjoyed a better state of health and their morale was higher. This was a vital factor in securing victory, and was undoubtedly largely attributable to the prolonged endeavours of the great admirals and the sea surgeons and physicians.

When wars ended, however, demobilization of the Fleet rapidly followed, naval funds disappeared, and the lively spirit of invention which had been nourished by the urgent needs of war evaporated. Lip-service frequently continued to be given to the need for preserving the welfare of the men ; but, although committees and commissions met to consider their wants from time to time, the recommendations made in time of peace were frequently unreal and out of keeping with the conditions of war, and suggested an unwillingness to face up to what might happen in the next war. All wars in the past seem to have been " wars to end war."

It was an unfortunate fact that the two Admiralty Ventilation Committees which met during the present century assembled after many years of peace when the lessons of the earlier wars were not fresh in the minds even of the naval executive officers concerned, and little account was taken of the severe conditions which might have to be faced in naval warfare under climatic extremes. It was even more unfortunate that these Committees closely preceded the outbreak of fresh wars, and there was inadequate time to implement many of the good recommendations that were made, whilst the new conditions of the new war caused a revision of others before they were put into practice.

In the past, scientists were usually called in to assist naval ventilation committees by advising on the conditions conducive to the maintenance of health and efficiency and on the ways of achieving them, and the naval interest in these problems undoubtedly served as a stimulus for certain individual researches which were undertaken on the problems of environmental hygiene. It appears, however, that the suggestions of the scientists were frequently only partly accepted, and their recommendations were not fully implemented, or else they were followed up with lack of energy and imagination, or with unwillingness to appreciate the practical problem, so that they were ineffective in practice. The whole neglect however, did not lie in material deficiency, waning interest, or inadequate or incorrect facts, but also in the official failure to promote planned research into the wide fundamental environmental problems involved.

This is an appropriate time, when the pattern of naval warfare in the future may be in the melting pot, to see that these mistakes are not repeated. Emphasis on the need for research is high at the present time, and the environmental problems which impaired health and efficiency in the 1939–45 War have been referred, since 1942, to the Royal Naval Personnel Research Committee of the Medical Research Council. This Committee considers on behalf of the Admiralty the physiological and psychological research necessary to add to fundamental knowledge and the ways of carrying it out. The problems of the thermal environment in ships are numerous and difficult, but they are being tackled by several teams of workers from the physiological and psychological aspects, and also by ventilation engineers, who try to meet the recommendations of the physiologists by improved equipment design. The basic work is well in hand, but the research workers still depend for a realistic appreciation of things as they are in the Fleet on the reports of observers with the Fleet, and on such routine returns as those made in accordance with recent Fleet Orders which relate to the health of ships' companies and to the assessment of undesirably warm thermal conditions.

There is thus considerable activity at the present time, and the degree of success achieved in providing ships' companies with an optimal environment in which to live and work under cruising and action conditions in the future will be largely assisted by its continuation, for many of the complexities have not yet been tackled whilst others

are not even clearly defined. The nutritional aspect of life in the arctic or tropics almost certainly merits further attention, to give one example, and the evidence on which we base the human requirements for cubic space or floor space on the messdecks and the criteria for the design of sleeping arrangements may well be reviewed in the light of modern developments.

This is, however, only part of the picture. Those sections of the Admiralty which state the requirements to be met when new ships are designed and built are closely associated with the research workers, and so are the designers. Thus the chances are relatively good that if new principles be discovered relating to man and his environment they will be given careful consideration when the difficult compromises between the many staff requirements for a fighting ship are framed in the future.

Trotter's dictum that "the fatherly care of a Commander is the Seaman's best Physician" is as true today as it was a hundred and fifty years ago. The skilful handling of ships, the careful maintenance of machinery, wise routines for operating it, and a well-judged balance between damage control precautions and the maintenance of reasonable habitability, will always be important when only a limited margin can be allowed to cover misuse or neglect of the equipment that is provided. The captain of a ship is always the principal hygiene officer, and the medical officer is only one of his advisers, with a relatively minor though important role to perform. On the other hand the medical officer's contribution to the fighting efficiency of his ship may be considerable and may extend far beyond his purely professional terms of reference for preserving health, curing disease, and treating injuries.

It would seem that an extension of the present lively interest in the environmental problems of the men in relation to their efficiency and health under all conditions of service will offer an excellent chance for enabling the "human machines"—as well as the weapons and mechanical devices they operate—to work with optimum efficiency under the conditions of modern war, and will thus enable us to keep faith with the early sea surgeons and physicians and the admirals who laid the foundations not only of naval hygiene but also of naval personnel research.

I am indebted to the Librarians of the Admiralty Library and of the Library at the Royal Naval Hospital, Haslar, for access to most of the historical works to which references are made, and to Miss E. Wigmore, Dr. J. J. Keevil, D.S.O., and Dr. E. Ashworth Underwood for indicating further useful references.

References

Admiralty Ventilation Committee Report (1914). H.M. Stationery Office.
——(1938). Unpublished.
Allison, R. S. (1943). "Sea Diseases." London.
Anonymous. (1920). *Nav. med. Bull., Wash.*, **14**, 563.
Bedford, T. (1946). Med. Res. Council. War Memorandum, No. 17, London.
Bernan, W. (1845). "History and Art of Warming and Ventilating." London.
Blane, G. (1799). "Observations on the Diseases of Seamen." London.
——(1815). "Comparative Health of the British Navy." London.
——(1822). "Select Dissertation on Medical Science." London.
——(1830). "The Health of the Royal Navy." London.
Callender, G. (1945). "The Naval Side of British History." London.
Clark-Kennedy, A. E. (1929). "Stephen Hales, D.D., F.R.S." Cambridge.
Cockburn, W. (1696, 1736). "Sea Diseases." London.
Cook, James (1776). *Philos. Trans.*, **66**, 402.
Critchley, M. (1945). *Brit. med. J.*, **2**, 145, 173, 208.
Desaguliers, J. T. (1727). *Philos. Trans.*, **35**, 353.
——(1735). *Ibid.*, **39**.
Dudley, S. F. (1928). *J. R. Nav. med. Serv.*, **14**, 77.
Ellis, F. P. (1947). *Brit. med. Bull.* (In the press.)
——(1948). *Brit. med. J.*, **1**, 587.
Ellis, H. (1751). *Philos. Trans.*, **47**, 211.
Fletcher, C. (1786). "A Maritime State Considered as to the Health of Seamen." Dublin.
Forbes-Guild, W. J. (1940). *J. R. Nav. med. Serv.*, **26**, 262.
Gillespie, L. (1798). "Advice to Commanders and Officers of His Majesty's Fleet Serving in the West Indies." London.
——(1800). "Observations on the Diseases on the Leeward Islands Station." London.
Hales, S. (1755). *Philos. Trans.*, **49**, 332.
——(1758). "Treatise on Ventilators." London.
Hill, L., Flack, M., McIntosh, J., Rowlands, R. A., Walker, H. B. (1913). "The Influence of the Atmosphere on our Health and Comfort in Confined and Crowded Places. Smithsonian Miscellaneous Collections." Vol. 60, no. 23.
Keevil, J. J. (1933). "Annals of Medical History." Vol. **5**, n.s. p. 511.
Laughton, (1866). "Nelson's Letters and Despatches. Admirals' Despatches. Mediterranean (1803)." **31**, 272.
Lind, J. (1754). "A Treatise on Scurvy." London.
——(1774). "On the Health of Seamen." London.
MacDonald, J. D. (1881). "Outlines of Naval Hygiene." London.
M'William, J. O. (1843). "Medical History of the Niger Expedition (1841–42)."
Moore, A. (1911). *St. Bart's Hosp. Rpts.*, **47**, 67.
Queen's Regulations and Admiralty Instructions (1899). Article 529.
Reid, D. B. (1844). Illustrations of Ventilation. London.
Shaw, T. B. (1928). *J. R. Nav. med. Serv.*, **14**, 1.
——(1929). "Manual of Naval Hygiene." London.
Sims, A. J. (1945). *Inst. Naval Architects.* April 17, 1945.
Sutton, S. (1744). "A New Method of Extracting Foul Air out of Ships." London.
Trotter, T. (1797). "Medicina Nautica." London.
Turnbull, A. (1904). "History of the Naval Medical Service." In the Library, R.N. Hospital, Haslar.
Turnbull, W. (1806). "The Naval Surgeon." London.
Underwood, E. A. (1947). *Ann. R. Coll. Surgeons*, **1**, 115.
Wilson, J. (1841). "Health of the Navy, 1830–1836."

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DUST SAMPLING IN A HÆMATITE MINE WITH THE P.R.U. HAND PUMP

BY

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Introduction

For dust assessment work in the coal-mines of South Wales and elsewhere, the Pneumoconiosis Research Unit of the Medical Research Council has found a hand pump, filter-paper, stain method to be of great value. Particular advantages of the method are the simplicity and portability of the sampling apparatus and the speed with which a large number of samples can be assessed. The sampling apparatus comprises a hand pump, in the head of which is inserted a small piece of white filter-paper. Air is drawn through the paper with the pump, and a "stain" is formed by the dust deposited on the front surface of the paper. The optical density of the stain can be related by suitable calibration to the amount of dust deposited, and hence to the concentration. A photo-electric densitometer is used to measure stain density.

It is likely that the method will be suitable for assessing other dusts that are coloured and that will produce a stain on white filter-paper. Assessment of white dusts collected on black paper may also be possible.

The present paper is an account of a trial in a hæmatite mine, where the dust is brick-red in colour. It was thought that the method might appreciably reduce the labour of sampling and assessment and thus make possible more frequent and comprehensive dust inspections and surveys of the type Craw (1948) has undertaken.

The P.R.U. Hand Pump

Description of Instrument.—As a full description of the P.R.U. (Pneumoconiosis Research Unit) hand-pump dust-sampling method has been published elsewhere (Watson and Hounam, 1948), it will be described here only briefly.

The hand pump (fig. 1) consists of a brass barrel in which moves a piston, provided with an oiled cup-leather, to give a swept volume of about 90 c.cm. To the inlet end of the pump is screwed a brass adaptor head. Into this is inserted a small brass hinged-clip which carries a piece of filter paper. The clip is held in position and air-tight seals made by tightly screwing down a sampling nozzle to register with a depression in the top surface of the clip. The underside of the clip seats on a rubber washer, cemented to the adaptor head. When the pump handle is pulled out, air is drawn into the barrel through the filter paper. On the return stroke most of the air within the barrel escapes past the cup-leather and only a small portion back through the paper.

The sampling kit consists of a hand pump and sixty numbered sampling clips, the clips being carried in a slotted wooden carrying box (fig. 1).

Whatman No. 1 filter paper has been found suitable, and squares with sides 1·75 cm. are inserted in the clips before they are sent from the laboratory. A circle of the paper 1 cm. in diameter is exposed by the clip, and it is on this that the dust is deposited.

Laboratory Preparation.—Leaks can occur in the system at a number of points.

(*a*) Between the walls of the barrel and the cup-leather. The leather should be soft and free from wrinkles. Oiling with light machine oil once a week is recommended.

(*b*) Between the underside of the clip and the rubber washer. If the washer is flat and firmly cemented in position, no trouble should be experienced provided the sampling nozzle is screwed down tightly and the clip has not become distorted.

(*c*) Between the top (that is, the sampling side) of the clip and the rear end of the nozzle. No leak should occur with clips in good order. A small leak at this point is, in fact, of no consequence under sampling conditions.

A quick check for leaks may be carried out with a clip in position by closing the entrance to the sampling nozzle with the thumb and drawing out the piston to its limit and holding it there. Quite small leaks can be heard in a quiet room. Underground, it is sufficient to note that if the plunger is pulled out with the nozzle closed, it returns immediately to the "in" position. It

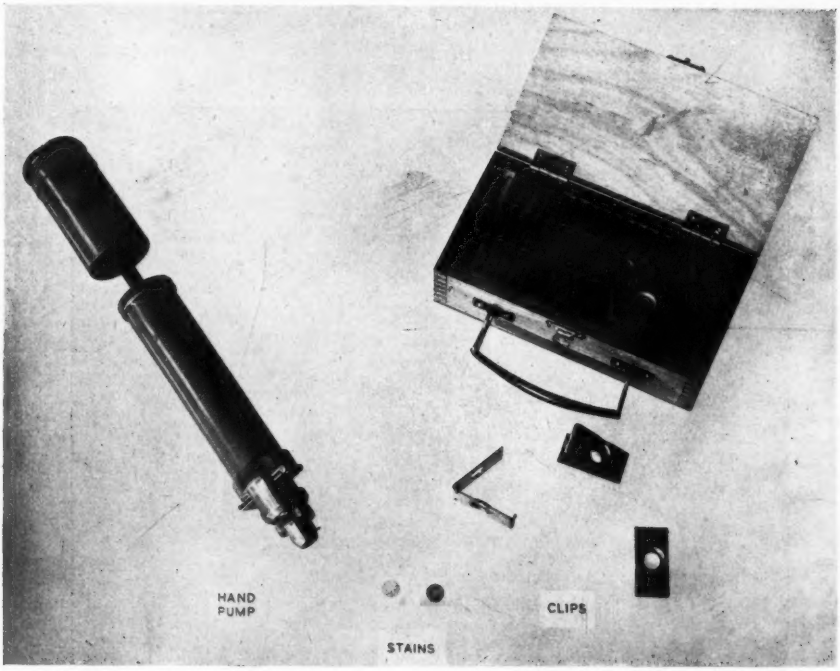

FIG. 1

FIG. 1. — P.R.U. hand-pump dust-sampling outfit.

FIG. 2.—P.R.U. densitometer.

FIG. 2

FIG. 3.—Manometer for testing hand pumps.

is better, however, actually to measure the volume of air displaced by a single stroke. This may be done with the aid of a simple manometer (fig. 3). It consists of a straight glass tube 50 cm. long and of internal diameter 1·8 cm., held with its lower end just below the surface of a trough of water. The tube is graduated in c.cm. from a zero mark 0·5 cm. above its lower end, and it is to this zero mark that the tube is inserted in the water. The pump is connected to the upper end of the tube with a short length of rubber tubing. When a stroke of the pump is made, the water rises in the tube. A pump in good working order will draw from 75 to 80 c.cm. of water into the manometer. As the air in the pump is held at a pressure less than atmospheric (by an amount equal to the height of the water in the tube) a correction to the indicated volume has to be made. For all practical purposes it is adequate to add 6 c.cm. to the indicated volume.

Sampling Procedure.—A pump that has been checked, together with a box of numbered clips loaded with clean filter papers, is taken to the sampling position. Except when sampling, a spare clip loaded with a piece of filter paper is inserted in the pump to minimize accidental entry of dust and dirt into the pump. At the sampling position the first clip is inserted into the pump head, the nozzle screwed tightly down, and sampling started.

Normally, the pump is held at right angles to any ventilating air current, and a stroke made every four or five seconds. The method of sampling is to pull the pump handle out quite smartly and to hold it for three to four seconds to allow all the air to be aspirated through the filter paper and the pressure inside the pump to be brought to atmospheric. When the handle has been returned, the next stroke is made. The number of strokes taken for each sample must be counted. Although a stain of any density can be measured, greatest accuracy is obtained with stains of optical density between 0·2 and 0·3. For this reason it is advisable to vary the number of strokes according to the dust concentration. Not more than 100 strokes will generally be required for any operation in a hæmatite mine with good dust-control measures.

Assessment of Stains : The P.R.U. Densitometer.—The hand-pump method does not give an absolute measure of dust concentration, so that the amount of dust in a stain must be determined by suitable calibration with a "standard" method (see below).

The optical density of the stain is measured by means of a photo-electric densitometer (fig. 2). A clip loaded with a filter paper is pushed into a slide in the densitometer. As the clip is inserted a shutter, which normally prevents light reaching the photo-cell, is depressed and the clip comes to rest in the correct position between lamp and photo-cell. A galvanometer indicates the photo-current through the cell. The deflection is set to the maximum of the scale (zero optical density) when a clip carrying a clean piece of filter paper is inserted in the densitometer. When a stained paper is inserted the galvanometer indicates a smaller current. The difference between this and full-scale deflection gives a measure of the stain density.

Calibration.—It has been found that the general relationship between Q and the number of particles producing a stain of optical density D is of the form

$$Q = aD^b \quad . \quad . \quad . \quad (1)$$

For coal-mine dusts b averages 1·5, and so the P.R.U. densitometer is graduated in terms of $D^{1\cdot5} \times 100$. The factor 100 is introduced to eliminate zeros after the decimal point in one step of the subsequent calculation. As will be seen later, a value of 1·58 was determined for hæmatite dust. No appreciable error will occur, therefore, in using the standard scale for hæmatite dusts.

To find the calibration constant for the particular dust being sampled, it is necessary to compare simultaneous samples taken with the hand-pump and a standard method. The illustration given below shows how to connect the stain density with the result of thermal precipitator sampling.

Suppose a thermal precipitator sample gives N particles per c.cm., and that the optical density of the corresponding stain is D when n strokes are taken with a hand pump of volume v ; we may write

$$N = \frac{S.D^{1\cdot5} \times 100}{nv} \quad . \quad . \quad . \quad . \quad (2$$

where S is a constant. Pump-volume v remains sensibly constant and for most pumps is about 82 c.cm. This value can, therefore, be taken into the calibration constant ; and we may re-write equation (2) thus

$$N = \frac{c.D^{1\cdot5} \times 100}{n} \quad . \quad . \quad . \quad . \quad (3)$$

In practice, it is usually sufficient to take four simultaneous samples with hand pump and thermal precipitator, and to use the mean value of c so obtained for all future work on the particular dust for which the calibration has been made. The value of c depends naturally on the physical characteristics of the dust, and, for a given dust, on the size distribution. It would seem adequate when sampling in a hæmatite mine to determine one value for the cloud produced by blasting and another one for that from loading out and from drilling. Some values for the dust at the Florence Mine using Whatman No. 1 filter paper have been determined and are as follows :

Blasting : $4\cdot7 \times 10^4$
Loading : $10\cdot6 \times 10^4$

Different values of c would be obtained using different grades of paper.

Thus, when a series of hand-pump samples is obtained, the optical-densities of the stains are measured, and the value of $D^{1\cdot5} \times 100/n$ determined for each. The number of particles per c.cm. is then simply obtained by multiplying by the appropriate value of c. This is a simple and rapid procedure, and once appropriate values of c are available routine sampling can be done on an extended scale and estimates of the dust concentration can be quickly obtained.

Calibration of the hand-pump stains can, of course, be made in terms of any dust-sampling instrument, for

TABLE 1
THERMAL-PRECIPITATOR SAMPLES

	Time after shots (min.)	Particles per c.cm.	Median Diameter (μ)	% Occurrence		
				<0·5 μ	0·5–2 μ	2–5 μ
After shot-firing	14	42,000	0·39	62	37·4	0·6
	20	36,000	0·32	70	28·9	1·1
	26	29,000	0·38	63	36·8	0·2
	35	16,000	0·37	63	35·6	1·4
While filling	—	4 300	0·23	85	15	—

instance with the Owen's jet dust counter, which is used by Craw in his work in the hæmatite mines.

Sampling at Florence Hæmatite Mine

Sampling Procedure.—Samples of the dust produced by different mining operations were taken with a thermal precipitator and with hand pumps.

As a matter of routine at this mine, all mining operations are done using well-proven methods of dust-suppression. An axial flow of water is fed to the drills used for drilling the shot holes. The dust produced by shot-firing is reduced considerably by using mist-projectors which project a fine spray of water into the heading before and for some fifteen minutes after the shots are fired. Normally two mist projectors are used, one some ten yards behind the other. During the present trials, the second mist projector was not turned on, so as to allow larger dust concentrations than normal to pass the sampling position, and for a longer time. The rock debris brought down is well watered before it is filled by shovel into trams.

The thermal precipitator was set up some ten yards outside a heading which had been driven off the roadway to a distance of about fifteen yards. Shot holes were prepared and fired. Four thermal-precipitator samples were taken of the cloud passing the sampling position at different times after the shots had been fired. One sample was also taken during "filling-out" in a nearby heading. Hand-pump samples were taken during each thermal precipitator sampling period and at other times during the passage of the cloud after shot-firing. Additional hand-pump samples were taken while holes were being drilled in another heading.

Acetylene lamps are used in this mine, and all thermal precipitator records were "incinerated" to remove carbon particles (see Watson, 1936–37, p. 181). The presence of carbon particles in the stains will affect their calibration, but, as these particles are very small, fairly large variations in the number present would not be expected to alter the calibration materially from day to day. In fact, very few were visible when the stains were examined microscopically.

Results.—The results of thermal-precipitator samples are shown in Table 1.

Hand-Pump Samples.—For the cloud reaching the thermal precipitator sampling position after shot-firing, the following empirical relationship was obtained between D, the optical density of the stain as measured by the P.R.U. photo-electric densitometer, and N, the number of particles per c.cm. as given by the thermal precipitator.

$$N = 4{\cdot}7 \times 10^4 \cdot D^{1{\cdot}58} \times 100/n \quad . \quad . \quad (4)$$

where n is the number of strokes taken to produce the stain.

The volume of air displaced by one stroke of each pump was 82 c.cm.

It will be seen that the index of D, viz. 1·58, is very close to the mean value of 1·5 that has been found to hold for coal-mines dusts.

From the single sample taken while filling out, no value of b (equation 1) was obtained; assuming it to be 1·58, a value for c of $10{\cdot}6 \times 10^4$ was derived by comparison with the single thermal precipitator result.

Using the above experimentally determined constants, particle concentrations as shown in Table 2 were obtained from the hand-pump samples.

Discussion.—Samples were taken with the thermal precipitator at this same mine in 1935 (Watson, 1935). It is interesting to record that a series of such samples taken in much the same relative positions as during the investigation forming the subject of this paper then gave, at fourteen minutes after firing, concentrations ranging from 31,000 to 54,000 particles per c.cm. These figures may be compared with the present result of 42,000 particles per c.cm. at the same time after firing. The 1935 results were obtained during the early days of mist projector experimentation when only one projector was used, as during the present trials.

TABLE 2

PARTICLE CONCENTRATIONS FROM HAND-PUMP SAMPLES

	Time after firing (min.)	Particles per c.cm.
After shot-firing	1	15,000
	2	111,000
	4	141,000
	6	190,000
	7	184,000
	9	118,000
	10	94,000
	11	109,000
	14	45,000
	20	39,000
	26	30,000
	30	59,000
	35	18,000
	23 (at face)	14,000
Drilling	—	3,200
	—	2,100
Filling out	—	4,300

TABLE 3

COMPARISON BETWEEN FINDINGS OF CRAW AND WATSON

	Craw	Watson
Solid-place (drilling)..	1,782–3,980	2,100–3,200
Working-end (filling)..	500–5,910	4,300
10 minutes after blast (Mist projectors working)	2,200–3.920 (Two mist projectors)	(94,000) (One mist projector)

The full size-distributions for the 1935 trials are not available, only the median particle sizes. The range after shot-firing of 0·30 to 0·48 μ may be compared with the present range of 0·32 to 0·39 μ.

Further comparisons can be made, with the concentrations determined with the Owens jet dust-counter (Craw, 1948) (Table 3).

The present results for drilling and for filling fall within the limits given by Craw. From a comparison of Craw's range of concentrations ten minutes after blasting and that obtained in the present trials, the second mist-projector appears to be highly effective. The single sample taken with the hand pump at the face twenty-three minutes after firing shows that the dust concentration was then much lower there than at the thermal precipitator sampling position.

Conclusions

Well-defined stains are obtained with the P.R.U. hand-pump dust-sampling apparatus when sampling air-borne hæmatite dust. This apparatus appears to be very suitable for use in hæmatite mines, and it should appreciably shorten the labour of routine dust determinations.

Thanks are due to Dr. Craw and to the Management of the Florence Hæmatite Mine for permitting this work to be done.

REFERENCES

Craw, J. (1948). "The Control of Silicosis in the Hæmatite Mines of the North West of England." Proceedings, Conference on Silicosis, Pneumoconiosis and Dust Suppression in Mines. pp. 68-87. London. Inst. Min. Engrs. and Inst. Min. Metall.

Watson, H. H. (1935). Unpublished report.

——(1936-37). *Trans. Inst. Min. Metall.*, **46**, 155.

——and Hounam, R. F. (1948). *Colliery Guardian*, **176**, 447.

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THE EVALUATION OF SKIN CLEANSERS AND PROTECTIVE CREAMS FOR WORKMEN EXPOSED TO MINERAL OIL

BY

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Introduction

In many industrial processes the workman's skin is constantly exposed to mineral oils which are known to be potentially harmful. Adequate removal of these oils from the skin after work, though desirable, is not easily accomplished, and the use of abrasive and excessively alkaline cleansers for this purpose is a frequent cause of skin disease in industry. Various cleansing agents free from these defects have now been marketed. In order to facilitate cleansing and to protect the skin during work, " barrier " or protective creams are frequently used. In this paper methods are described of estimating the effectiveness of these agents. The experiments were carried out directly on the human skin, since it is believed that only by reproducing as accurately as possible the natural conditions of use of these substances can a reliable assessment of their efficiency be obtained.

Evaluation of Cleansing Agents

Principles of Method

Fluorescence of Oils on the Skin.—Uncontaminated oils are invisible on the skin in small amounts, so that the effectiveness of their removal cannot be assessed by direct examination. This difficulty was overcome by utilizing the fact that most mineral oils produce a brilliant violet fluorescence when examined in ultra-violet light. This method of detecting the presence of mineral oil is extremely sensitive. If the forearm is contaminated with machine oil, a short wash with soap and water will render the arm apparently clean ; but when the arm is examined under the ultra-violet lamp, brilliant pin-points of fluorescence in the hair follicles betray the presence of unremoved oil. The intensity of this fluorescence gives a measure of the amount of oil remaining, and thus provides a means of comparing the efficiency of detergents.

Standardized Oil Contamination

Choice of Oils.—Some oils are more easily removed from the skin than others ; for example, a light spindle oil is more easily removed than a heavy gear oil. In general, the more viscous the oil, the more difficult its removal. By selecting three oils graded in this property for each experiment, differences in cleansers can be readily appreciated. Thus a very efficient cleanser removes even heavy oils, whereas a poor cleanser removes only spindle oil. Further, by choosing several oils in general use, the results are made more widely applicable. The oils chosen were :

1. Machine oil of viscosity 100 secs. Boverton-Redwood at 140° F.
2. Cutting oil of viscosity 50 secs. Boverton-Redwood at 140° F.
3. " Soluble " oil used without the addition of water.

Of these, machine oil was the most, and cutting oil the least difficult to remove, " soluble " oil being intermediate in this respect.

Site and Amount of Contamination.—The three oils were applied to corresponding, adjacent areas on the extensor aspect of each forearm, one drop of each oil being spread to cover a rectangle of constant dimensions. It is necessary to choose similar areas for the application of each oil as there are considerable differences in the nature of the skin of various parts of the hand and forearm. Such differences as the number and depth of the hair follicles and the degree of keratinization affect the result of the test.

The Use of Soap as a Standard of Comparison.—The arms having been contaminated identically, the right arm was washed in each experiment with the detergent under test, and the left with a stock 4 per cent. solution of white domestic soap. When examining the results, the left arm was used as a standard of comparison. It also afforded a check that the conclusion was not falsified by the introduction of some unexpected variable.

Other Factors affecting Detergency.—The efficiency of a detergent is affected by the amount of friction with which it is applied to the skin. In order to obtain light,

even friction, a shaving brush was used to apply the detergents. The duration of washing was timed with a stop watch. Soft water at 40° C. was used throughout the experiments. The tests were carried out on six subjects. There appeared to be a slight variability in the ease with which the oils could be removed from the skins of different individuals, but as the control wash with stock soap solution was carried out in each case, this factor did not affect the results.

Comparison of Washed Arms.—After washing, the amount of each oil remaining in the hair follicles was estimated by two methods :

(i) The hair follicles in four squares of 1 sq. cm. were counted and recorded as fluorescing brightly, slightly, or not at all. Any great variation in these counts in any one oil-area after washing was due to the fact that washing has been uneven, and the experiment was repeated.

(ii) A permanent record of the fluorescence was obtained by photographing each stage of the experiment under standardized conditions. This enabled a clear comparison to be drawn between experiments performed at various times, but was not essential to the performance of the test.

Details of Technique

Light Source.—The source of ultra-violet light was a portable mercury vapour arc (current consumption 300 W. at 200 V.). It was screened with a filter of Wood's glass. To demonstrate the fluorescence the arm was held at a distance of approximately 12 inches from the lamp. A therapeutic ultra-violet lamp suitably screened could alternatively be used.

Photographic Technique.—The camera position was standardized at a distance of 2 feet from the extensor surface of the forearm. Most of the photographs were taken on a Super XX film with an exposure of 35 to 45 secs. at F.11. A colourless gelatine filter was used to cut off the ultra-violet radiation reflected from the arm. Various filters, nominally the same, were tried, and showed considerable variation in their opacity to ultra-violet radiation. A process of trial and error was required to find a suitable filter.

Method.—Three rectangles of 15·6 sq. cm. were marked out on the corresponding areas of the extensor aspect of each forearm. One drop of each oil was spread with a glass rod to cover the appropriate rectangle and at this stage the arms were photographed (figs. 1 and 2).

The left arm was now washed for half a minute with the stock 4 per cent. soap solution. This was in the form of a loose gel which was suitable for application with a shaving brush. The right arm was washed for half a minute with the detergent under test. After washing, both arms were thoroughly rinsed, and dried by dabbing with a soft cloth. The arms were then compared and re-photographed (figs. 3 and 4).

The arms were given a further one-minue wash, then rinsed and dried as before. The final comparison was made and the arms photographed a third time (figs. 5 and 6).

Table 1

RELATIVE EFFICIENCY OF CLEANSING AGENTS IN REMOVING MINERAL OIL FROM THE SKIN

Cleanser	Grade
2% Domestic soap solution	V
4% Domestic soap solution	IV
25% *Sapo mollis* B.P. solution	III
50% *Sapo mollis* B.P. solution	II
Soap powder	II
Soap powder 50% Woodflour 48% Borax 2%	I
Soap powder 50% Woodflour 42% Borax 2% Sodium pyrophosphate 6%	I
Ether soap B.P.	III
Compound cleanser 'A'*	I
Compound cleanser 'B'†	I
Triethanolamine alkyl sulphate	IV
Sodium secondary alkyl sulphate	IV
Sodium oleyl p-anisidate sulphonate ..	III
Sulphonated castor oil	III
Sulphonated oleate	II
Ethylene oxide condensate A	II
Ethylene oxide condensate B	V
Ethylene oxide condensate C	V
Cetyl trimethyl ammonium bromide (crude) 1%	IV
Cetyl pyridium bromide (crude) 1% ..	IV

* Compound Cleanser 'A' is a mixture of soap and white spirit.

† Compound Cleanser 'B' is a mixture of mineral oil, white spirit, and sulphonated castor oil.

Results

The results are shown in Table 1. In this table five grades of efficiency are indicated. They express the degree of removal of the various oils from the hair follicles after one and a half minutes' washing. Their significance is as follows :

Grade I. Removed all three test oils.

II. Failed to remove machine oil only.

III. Removed cutting oil completely ; partly removed " soluble " oil and machine oil.

IV. Removed cutting oil completely ; considerable amounts of both " soluble " oil and machine oil remained in follicles.

V. Failed to remove all three oils.

The efficiency of soap in various concentrations was first investigated. A solution of less than 2 per cent. had negligible detergent properties when acting upon a surface heavily contaminated with oil. The 4 per cent. solution taken as the standard of comparison was reasonably efficient (Grade IV) and the efficiency increased with higher concentrations. To obtain 25 per cent. and 50 per cent. solutions of soap,

the more soluble *sapo mollis* B.P. had to be used. This provided an imperfect turbid "solution" which, however, remained fluid. Soap powder is the most concentrated form of soap possible. Used alone this was unsatisfactory from a practical point of view in that the addition of water caused clumping and caking of the particles.

Caking was avoided, and the detergent properties of the soap greatly improved by using a mixture containing equal parts of woodflour, and milled, dried soap powder. The woodflour was of such a consistency that when water was added to the mixture a smooth paste was formed. Washing with this paste was very efficient. It seems likely that the woodflour, in addition to preventing caking, acts as a mild scrubber and provides an alternative surface to which the oil may become attached. The inclusion of woodflour in a tablet soap is not recommended, as under these conditions the tablet becomes rough and abrasive.

Of the other cleansing agents examined, only those described as 'Compound Cleanser A' and 'Compound Cleanser B' were much superior to soap. Both of these cleansers suffered from the defect that rinsing from the skin was difficult. Although the oil appeared to be loosened from the hair follicles, a fine fluorescent film was left behind on the skin after rinsing (fig. 7). Neither of these cleansers lathered to any extent, and it is possible that the increased surface area provided by a lather assists in keeping the oil in suspension. The absence of a lather also makes it difficult to see when rinsing is complete. The residual mixture of cleanser and oil can be removed by a second wash, preferably with soap and water.

The sulphonated oils tested, sulphonated castor oil and sulphonated oleate, were no more efficient than soap. The addition of an unsulphonated oil such as oleic acid, to the sulphonated oleate increased its power to loosen the test oils from the hair follicles, but reduced its rinsing properties. The addition of triethanolamine alkyl sulphate in the proportion of 2 per cent. to each of the sulphonated oils increased their efficiency—mainly by improving the stability of the final emulsion. However other considerations may make the use of a sulphonated oil advisable, for instance in the case of a worker whose skin has become damaged by exposure to an excess of alkali (Schwartz, 1941).

Of the other detergents examined, none was sufficiently superior to soap to justify its use on grounds of efficiency.

Further Investigation of Selected Cleansers

The three most efficient cleansers, namely soap-woodflour, 'Compound Cleanser A,' and 'Compound Cleanser B,' were now compared with each other using heavy gear oil (viscosity Boverton-Redwood—1,000 secs. at 140° F.) as the test oil. Experiments had previously demonstrated the difficulty of removing this oil from the skin.

Method.—One drop of the test oil was placed on each forearm and worked into the skin till it covered an area the size of a penny. Each arm was then washed with the shaving brush for one minute, the left with the soap-woodflour cleanser, the right with the 'Compound Cleanser A.' The arms were compared as before. The experiment was repeated comparing the soap-woodflour cleanser with the 'Compound Cleanser B.'

Result.—None of these cleansers removed all traces of the gear oil from the hair follicles. The soap-woodflour mixture showed a great advantage over the other two cleansers in that final rinsing from the skin was satisfactory. After the use of either of the 'Compound Cleansers,' a considerable amount of contaminating oil was deposited on the skin surrounding the original patch.

Alternative Method of Skin Cleansing.—It is the habit in some factories to clean the arms with a vegetable oil before washing with soap and water. Jones (1944) refers to the use of cotton-seed oil for this purpose. Experiments were performed in which the oil-contaminated arms were anointed with medicinal paraffin, and then washed by the standard technique. This method proved very efficient. Castor oil and oleic acid were similarly effective and it is likely that any bland oil of sufficiently low viscosity would be suitable for use in this way. This was the only method which removed the heavy gear oil completely from the hair follicles.

Practical Washing Trials.—Several washing trials of a more practical nature were carried out. In these trials the subjects washed their hands and forearms in the way to which they were accustomed. Only the duration of the wash was controlled. The results of these trials with the different cleansers corresponded closely with those of the standard experiments.

Observations made during these and previous experiments have shown that the efficiency of ordinary toilet soap varies greatly with the method of use. The best results were obtained by washing according to the following rules:

1. Do not wet the arms.
2. Using a minimum of water, work the soap from the tablet with the palms until a thick paste is formed.
3. Massage this paste into the skin.
4. Thin the resultant mixture of oil and soap by gradually adding water until a lather is formed.
5. Rinse thoroughly.

It was proposed to extend trials of this nature to a group of workers in an automatic machine shop. These men become heavily contaminated with cutting oil. They were asked to report for examination during their working period and requested to refrain from washing before attending. Examined under the ultra-violet lamp, their arms showed the brilliant fluorescence of mineral oil. After they had washed, however, a considerable amount of fluorescent material remained on their arms. It appeared to be mainly in the hair follicles although not confined to these areas, and it could not be removed by oil-solvents such as acetone and xylol. Further examination of the material responsible for the fluorescence showed that it was keratin. Some of these small keratin aggregates were visible in ordinary light as comedoes. It is difficult to distinguish the fluorescence of these keratin " plugs " in the hair follicles from that of small amounts of mineral oil, and consequently a satisfactory washing trial in this group of workmen was impossible.

Comment.—It has been clearly shown that the removal of certain types of mineral oil from the skin is not easy. The removal of all but the most viscous oils can be accomplished by three of the cleansers examined, viz., soap-woodflour mixture and compound cleansers ' A ' and ' B.' The soap-woodflour mixture was the most satisfactory in that final rinsing from the skin was easier.

By using a double procedure of washing first in a " thin " bland oil such as medicinal paraffin, and then washing with soap and water, even the most viscous oils could be removed.

The Removal of Skin Fat by Cleansing Agents.—The use of powerful cleansing agents is attended by the danger of removing excessive amounts of natural fat from the skin. A few experiments were carried out to measure the amount of fat which might be removed in this way.

The amount of fat normally present on the surface of the skin was ascertained by immersing the hand and forearm in a cylinder of acetone for three minutes. The acetone was centrifuged to remove particulate matter and distilled. A residue of brown fat was obtained which amounted to about 60 mg. from one hand and forearm—representing a surface distribution of 0·06 mg. per sq.cm. Extraction of the fat from the skin in this way caused no ill effects beyond a slight dryness of the skin for an hour or so. In one subject mild " chapping " persisted for twenty-four hours. Repeated extraction of skin fat at varying intervals indicated that complete recovery might occur in four hours.

By extraction after washing with selected cleansers the amounts of fat removed by these agents could be obtained by difference. Thus washing for one minute with soap and water removed about one-fifth of the " extractable " fat, while washing for one minute with ' Compound Cleanser B,' which contained a fat solvent, removed nearly half of the " extractable " fat. The soap-woodflour cleanser also removed almost half of the " extractable " fat.

Thus the most efficient cleansers removed considerably more of the skin fat than did soap and water. As considerable variation in the fat replacement rate is likely, the frequent use of these cleansers by susceptible individuals may result in " chapping." In these individuals the use of an emollient cream after washing may be necessary to protect the skin until replacement of the natural fat has occurred.

Evaluation of Barrier Creams

The use of barrier creams is intended to lessen skin contamination and to make cleansing easier. Although the present investigation was concerned mainly with the oil-resisting properties of barrier creams, several creams which did not purport to be oil-resisting were also tested. In all, twenty-six creams were examined, including samples of most of the creams at present in use in industry. For descriptive purposes each of these creams was given a code letter.

The creams investigated were arranged in three groups according to their general composition. A finer classification appeared unnecessary in view of the lack of differentiation in efficiency which was demonstrated. The groups were as follows :

Group I.—This group consisted of non-greasy creams, the basis of which was soap. Other oil-insoluble bases were sometimes included. The creams were " filled " with various inert powders. Their water content was relatively low.

Group II.—The creams in this group were mainly of the " vanishing " type designed to deposit either fats, soap, or cellulose bases in the hair follicles. Their water content was relatively high.

Group III.—This group consisted of creams made from various oily bases. Varying amounts of inert powder were included. Water was never present as a major constituent.

The oil-resisting properties of these creams were first compared. Further experiments were then performed on individual creams to ascertain their efficiency under varying conditions.

Comparison of Barrier Creams

The method was a modification of that used for the comparison of detergents, and the same general principles were maintained. Films of cream were applied to the extensor aspect of the forearm and

TABLE 2

PENETRATION OF BARRIER CREAMS BY OIL (FIVE TO TEN MINUTES CONTACT TIME)

Type	Code letter	Stated function	Degree of penetration
I (Soapy base)	A	Oil-resisting	Slight
	B	,,	,,
	C	,,	,,
	D	,,	,,
	E	,,	Moderate
	F	Oil and solvents	,,
II (Vanishing cream)	G	Oil- and water-resisting	Moderate
	H	Water-resisting	,,
	I	Dust and powders	,,
	J	Oil-resisting	,,
	K	,,	Gross
	L	,,	Moderate
	M	,,	,,
	N	,,	Gross
III (Greasy base)	O	Water resisting	Moderate
	P	,,	,,
	Q	,,	,,
	R	,,	,,
	S	,,	,,
	T	,,	,,

contaminated with machine oil. Machine oil was chosen as it is of low enough viscosity to be fairly penetrating, and yet is difficult to remove from the skin once penetration has occurred. In each experiment a control contamination of normal skin was made. The arm was washed and dried in the standard method.

Method.—Three rectangles (15·6 sq. cm.) were marked out on each forearm. Approximately the same amounts of four barrier creams were rubbed into each of the outer rectangles. The normal skin in the central areas was left untreated to provide controls. A thin film of machine oil was painted on all six rectangles (figs. 8 and 9). Each arm was then washed for one minute by the standardized method and the fluorescence in the different patches subsequently compared. Thus on each arm two creams were compared with each other and with a control of untreated skin (figs. 10 and 11).

Results.—The results are expressed in Table 2. The degree of penetration is assessed as "gross" where the fluorescence of the oil on the protected area is as great as on the control area; "moderate" where the fluorescence is notably less, and "slight" where there is some evidence of oil in the hair follicles but the fluorescence is barely discernible.

It will be seen from Table 2 that only "slight" penetration of oil occurred through four of the creams of Type I. These "oil-resisting" creams (A, B, C, D) were definitely superior to all the others when tested as described. The two creams (K, H) which allowed "gross" penetration were vanishing creams with a very high water content.

The greasy water-resisting creams of Group III appeared, somewhat surprisingly, to have exercised some protection of the skin. From the composition of these creams it seems more likely that this effect was due to the fact that they assisted in the removal of the oil, rather than that they prevented contamination of the skin. This point was elucidated in an experiment to be described later.

The general conclusions from this test were thus:

1. Certain creams of Type I might be of some value.
2. High water-content creams were unlikely to be of any value.
3. Fatty creams might assist in the removal of oil from the skin.

THICKNESS OF CREAMS

In the previous experiment a liberal application of cream had been made. The effect of varying the thickness of the cream was now investigated. Creams A, B, C, and D were tested in this way, as they had already shown themselves the most promising.

It is not possible to measure accurately the thickness of a film of cream on the skin, but by rubbing in known weights of cream over equal areas the approximate thickness of the film may be calculated. This method is no doubt open to error due for instance to local variations in film thickness; but the variations are negligible in comparison with those occurring when the cream is used under practical conditions.

Method.—Three equal rectangles were marked on the

TABLE 3

PENETRATION OF OIL THROUGH FILMS OF VARYING THICKNESSES

Film	Weight of cream per rectangle (g.)	Estimated thickness (μ)	Degree of penetration	Appearance of film
1	0·1	64	Gross	Thin transparent layer ("invisible glove")
2	0·2	120	Very slight	Distinctly visible though practical to wear
3	0·3	190	Nil	Thick coating
4	0·4	250	Nil	Even thicker coating

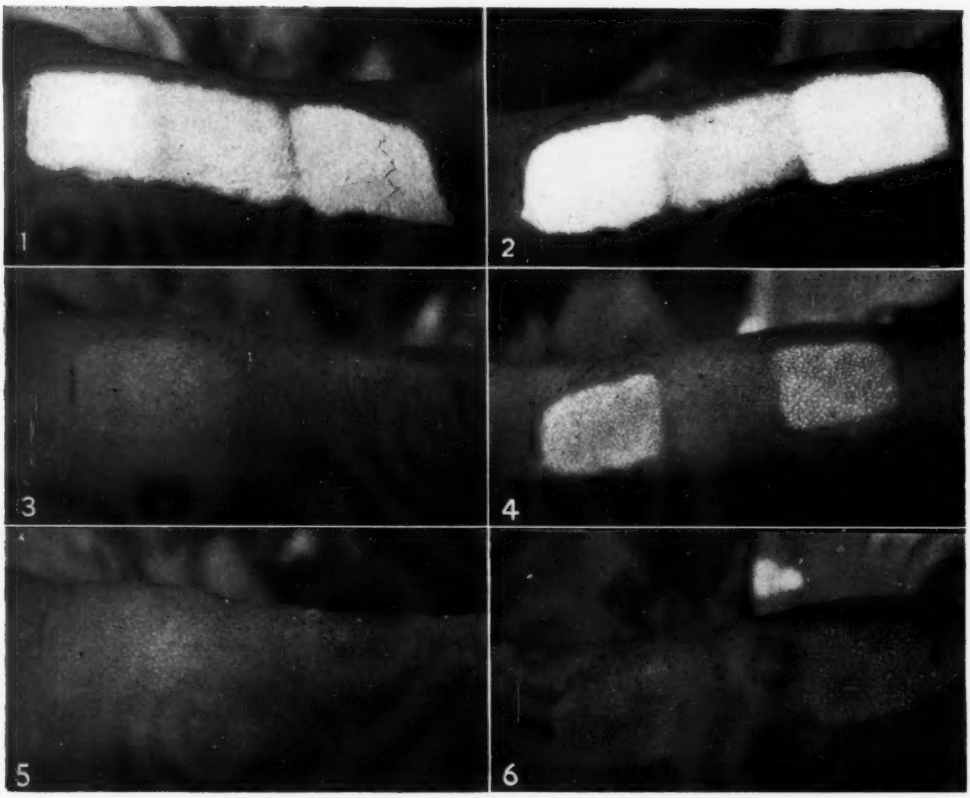


FIG. 1.—Machine oil, cutting oil, and soluble oil (left to right), applied to right forearm.

FIG. 2.—Machine oil, cutting oil, and soluble oil (right to left), applied to left forearm.

FIG. 3.—Right forearm after half a minute's wash with soap-woodflour cleanser.

FIG. 4.—Left forearm after half a minute's wash with four per cent. soap solution.

FIG. 5.—Right forearm after a further one minute's wash with soap-woodflour cleanser.

FIG. 6.—Left forearm after a further one minute's wash with 4 per cent. soap solution.

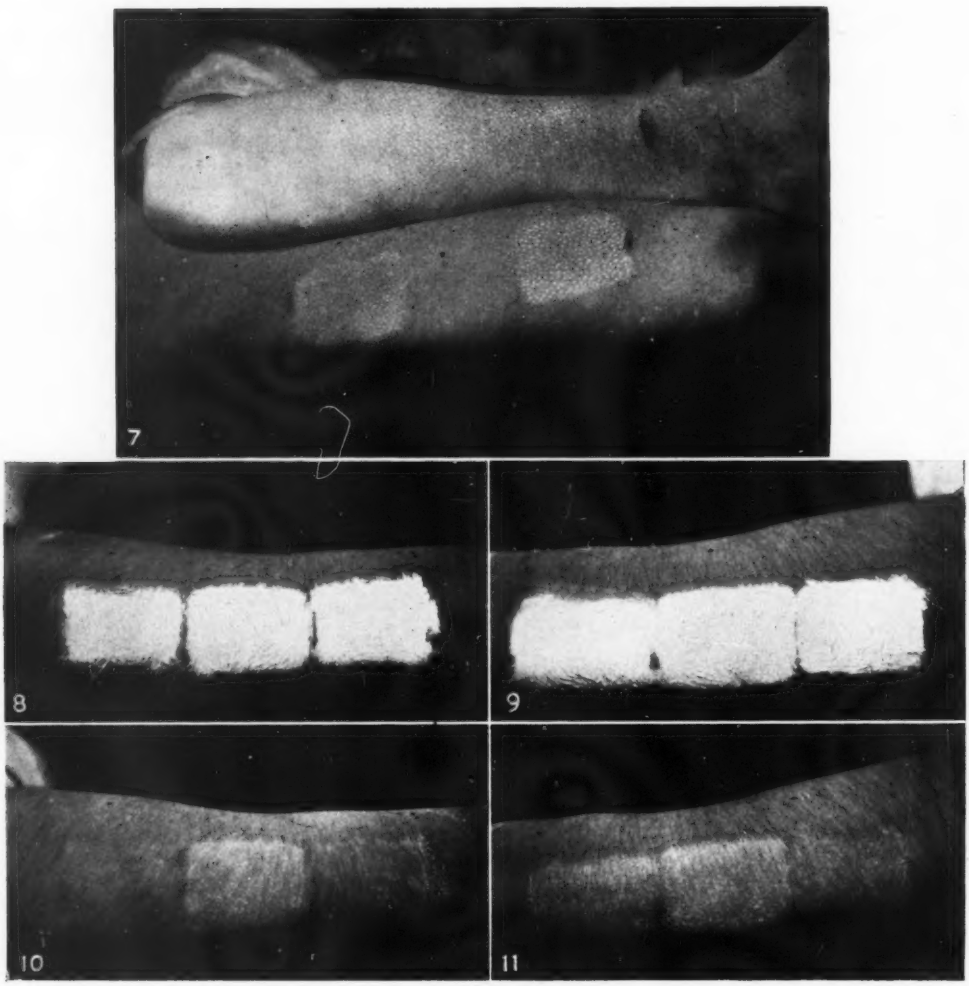


FIG. 7.—Comparison of arms washed for one and a half minutes with the "compound cleanser B" (right arm) and 4 per cent. soap solution (left arm). "Compound cleanser B" removes the oil more efficiently from the contaminated area. A considerable amount of oil is redeposited elsewhere, especially in the elbow region, where rinsing is difficult.

FIG. 8.—Film of machine oil covering (from left to right) cream B, normal skin, and cream J.

FIG. 9.—Film of machine oil covering (from left to right) cream K, normal skin, and cream J.

FIG. 10.—After washing for one minute. "Slight" penetration through cream B, "moderate" penetration through cream J.

FIG. 11.—After washing for one minute. "Gross" penetration through cream K, "moderate" penetration through cream J.

extensor surface of each forearm ; 0·1 g., 0·2 g., 0·3 g., and 0·4 g. of cream A were rubbed into the outer rectangles. The central patches again acted as controls. A film of machine oil was painted over all six rectangles. The arms were immediately washed in the standard manner for one minute. The degrees of fluorescence in the areas were compared. The experiment was then repeated with creams B, C, and D.

Results.—The results are expressed in Table 3.

There was no difference in the efficiency of the four creams tested. Each was totally inefficient in the thinnest film, but as the thickness of the cream was increased, improvement in efficiency occurred. Unfortunately, however, the films which were completely effective are too thick to be of practical value.

Effect of Prolonged Contamination

In the previous experiments the creams were exposed to mineral oil for a short period only (less than ten minutes). In the following series of tests the effects of increasing this exposure were demonstrated. The creams A, B, C, and D were subjected to this test. In addition a simple preparation consisting of 70 per cent. lanoline and 30 per cent. castor oil as an example of a greasy cream was tested in the same manner.

Method.—A film of cream was applied to the forearm. The film was approximately 120 μ in thickness, that is, it corresponded to film 2 in the previous experiment (Table 3). Both the "protected" and the untreated skin were contaminated with a drop of machine oil. In a series of experiments the oil and cream were left in contact for varying periods up to one hour. During this time the subject carried out light laboratory duties with the sleeves rolled up. At the end of the period the arm was washed in the standard manner for one minute and the "protected" area compared with the control area.

Results.—The results are tabulated below in Table 4.

These results demonstrate the ineffectiveness of Creams A, B, C, and D in resisting the penetration of mineral oil for more than a short period. The lanoline and castor-oil cream showed no such loss of efficiency with time. *In vitro* tests with coated filter paper show that the lanoline cream is much more readily penetrated by mineral oil than the soapy creams. It must therefore be concluded that the observed effect is due to the fact that it facilitates the removal of the oil, rather than prevents physical contact with the skin.

Comment

The results of these experiments indicate that the soapy barrier cream designed to resist oil penetration, although effective for short periods such as half an hour, permits complete penetration of oil when the duration of the contamination is of one hour or more. In these experiments, much thicker films were used than are generally recommended. Where thinner films were used (64 μ) the soapy creams were totally ineffective—even this thickness being much greater than the 30 μ often advocated. The liquid vanishing creams were valueless.

The greasy creams, although incapable of functioning as "barriers," appeared to assist in the removal of oil.

TABLE 4

EFFECT OF INCREASING EXPOSURE TIME OF CREAMS TO MACHINE OIL

Cream	Residual fluorescence after washing				
	Immediate removal	After ¼ hour	After ½ hour	After ¾ hour	After 1 hour
A	nil	V. slight	Mod.	Gross	Gross
B	,,	,,	,,	,,	,,
C	,,	,,	,,	,,	,,
D	,,	,,	,,	,,	,,
Lanoline + castor oil	V. slight	,,	V. slight	V. slight	V. slight

Discussion

It is not claimed that an exhaustive examination of cleansing agents and protective creams has been made. The aim has been to evolve a method by which such compounds can be evaluated by the medical officer in industry. Nevertheless the investigation has yielded useful information concerning the problem of skin contamination by mineral oil. Data obtained from laboratory experiments such as these cannot be regarded as conclusive. The final judgment must be based upon the results of a user trial. The difficulties of conducting satisfactorily controlled user trials are unfortunately very great. However, it appears unlikely that any compound which failed to satisfy the criteria of the tests described would be of much value in practice. The converse is obviously not true—an agent which satisfies the laboratory tests may still fail under practical conditions. This is true of protective creams in particular. In these experiments no account has been taken of such factors as visible perspiration which occurs when heavy manual labour is done ; nor have the creams been tested with regard to their ability to stand up

to the friction ordinarily encountered during work from clothing and other agents.

As judged by our experiments the value of barrier creams to those exposed to gross oil contamination would appear to be low. A film which would be practical to wear fails to prevent penetration of oil into the hair follicles if the duration of the contamination is greater than one hour. Once penetration has occurred the soapy "oil-resisting" cream does not appear to assist in the removal of the oil. The greasy cream, although it rapidly becomes mixed with the contaminating oil on the skin, assists in subsequent cleansing. As a result of clinical observation and animal experiments, Twort (1934) suggested the use of a mixture of lanoline and olive oil as a protective application for oil workers. It is possible that the use of a cream of this type may be of benefit in two ways—diluting the contaminating oil on the skin and assisting subsequent cleansing. It is accordingly suggested that where, by reason of popular demand, a protective cream for oil workers is required, it should be of a fatty nature. It must be recognized, however, that the use of such a preparation cannot be regarded as affording a great deal of protection, and it must not distract attention from other and more valuable means of preventing oil contamination, such as the use of protective clothing, the provision of adequate washing and laundry facilities, and other measures of general hygiene.

Since reliance cannot be placed upon protective applications, it becomes more important to achieve the satisfactory removal of oil from the hair follicles after work. These experiments have shown that this is not a simple problem, and that particular care must be exercised in washing. The tests have defined certain agents which are likely to be of value; of these the most efficient was a mixture of soap powder and woodflour. The woodflour used in this cleansing mixture should be fine enough to pass a 40 mesh and it should not be derived from any wood which is likely to possess sensitizing properties. The soap powder should contain a minimum of free alkali.

The use of powerful cleansing agents is accompanied by the risk of removing too much of the natural skin fat. Although in most people this risk is not likely to be great in view of the rapid replacement of fat lost from the skin, the continued use of such agents by certain individuals may result in excessive dryness of the skin and chapping in dry weather. This may be avoided by the use of an emollient cream after work in order to compensate for any fat loss.

The alternative method of a preliminary wash in thin bland oil before using soap and water has been shown to be efficient and to cause minimal skin trauma; it has the disadvantage of being a double procedure but should not be difficult to put into practice as workmen are all too keen to use kerosene or other solvents before washing.

It has thus been shown that the prevention of skin contamination by mineral oil is not easy. There is no doubt that directly or indirectly mineral oils cause a considerable proportion of industrial skin disease. Elimination of this group of skin diseases is only likely to be achieved by improving the design of machinery to reduce the risk of contamination or possibly by the substitution of oils which are non-irritating to the skin. That the use of protective creams or powerful cleansing agents is considered, must be a reflection upon our standards of engineering efficiency.

Summary

1. A method is described of assessing the value of cleansing agents and protective creams to workmen exposed to mineral oils. The method is based on the detection in ultra-violet light of oil persisting in the hair follicles after the use of these agents.

2. A number of cleansing agents have been examined. Of these a mixture of equal parts of milled, dried soap-powder, and fine woodflour gave the most satisfactory results.

3. A range of proprietary barrier creams has been examined. None of these gave satisfactory protection of the skin.

4. The excessive removal of fat from the skin is discussed, and a method of investigating this problem is described.

I wish to thank those manufacturers of cleansing agents and barrier creams who so kindly supplied me with samples of their products. Their co-operation and advice has been of considerable help.

For much helpful criticism and advice I am indebted to Dr. J. R. Squire, Director of the Medical Research Council Industrial Medicine Research Unit, Birmingham Accident Hospital, at whose suggestion this investigation was carried out, and for assistance in the estimations of skin fat, to Dr. C. R. Ricketts.

References

Schwartz, L. (1941). *Publ. Hlth. Rep., Wash.*, **56**, 1790.
Jones, A. Thelwall (1944). *Brit. J. industr. Med.*, **3**, 83.
Twort, C. C., and J. M. (1934). *Lancet*, **1**, 286.

BOOK REVIEWS

THE PRACTICE OF INDUSTRIAL MEDICINE

By T. A. Lloyd Davies, M.D., M.R.C.P.

(J. and A. Churchill. London. 1948. Pp. 248. Price 15*s.*)

We greatly welcome the appearance of a British treatise on industrial medicine, particularly when it has been written by somebody so well versed in all aspects of industrial medicine as Dr. Lloyd Davies. This book is nicely balanced between the many approaches to the subject, and this is well shown by the chapter headings: Historical and Introductory Survey; Medical Examination; Accidents, Fatigue, and Environment; The Social functions of Industry; Industrial Disease and Toxicology; The Hazards of Coal-mining; Workman's Compensation and Rehabilitation. The author's greatest interest in industrial medicine is in the social aspect of it, and in this he is right, for as he says: "The social and environmental circumstances of industry affect all persons employed under industrial conditions, whereas relatively few workmen are exposed to the risk of industrial disease." His exposition of the problem of adolescence in industry is outstanding, but he does not deal with the social aspect to the exclusion of any other. The toxicological section is as complete a reference section as any industrial medical officer could wish for; and here again the author's own work on manganese pneumonia is the most outstanding piece of original toxicological work which has been done by any industrial medical officer in the past ten years. In this section prevention is stressed, as it rightly should be, since every industrial disease is preventable.

The factory department of the Ministry of Labour, which has done so much to further industrial medicine in this country, has perhaps grown up on the prevention of accidents and the various aspects of this subject are well discussed. Physiological requirements include the maintenance of pure atmosphere, the right temperature, adequate lighting, avoidance of excessive noise, adequate space, and good nutrition. Psychological requirements are that there shall not be mental or physical fatigue but that recreational facilities shall be available; whilst hygiene and social standards shall be those prevailing in the community. At the same time there shall be protection against infection and accidents and this means that the engineering shall be of a high standard and properly executed. As the author writes, the primary duty of every industrial medical officer is to prevent accidents and to ensure that the workman will not be harmed. However, if the worst happens, it is important that he should know about workman's compensation and rehabilitation; and this chapter, like the rest of the book, is well written.

No praise can be too high for this book and it is to be hoped that every industrial medical officer will read it and will see that there is a copy on the bookshelf in his works surgery. *K. M. A. P.*

TUBERCULOSIS IN YOUNG ADULTS

Report on the Prophit Tuberculosis Survey, 1935-1944.

By Marc Daniels, Frank Ridehalgh, and V. H. Springett

(H. K. Lewis and Co. London. 1948. Pp. xvi+228. 58 plates. Price 30*s.* net.)

Over a period of ten years more than 10,000 young people have been examined by tuberculin tests and radiographs. Five main groups were examined: nurses, medical students, contacts, Navy boys, and a group of controls consisting mainly of office workers. The mean age was 21 in nurses, medical students, and controls, 18 in contacts, and 16 in the group of Navy boys. The nurses were divided into two groups, those nursing the chronic sick and including many Irish and Welsh girls, and those in ordinary general hospitals.

The tuberculin test was positive on entry in 85 per cent. of males and 82 per cent. of females; and was about 10 per cent. higher at 23 than at 18 years of age. On routine *x*-ray examination 0·5 per cent. had active tuberculous lesions, 1 per cent. showed evidence of inactive reinfection tuberculosis, and up to 9 per cent. showed evidence of calcified foci; 85 per cent. of visible pulmonary lesions occurred in the upper zones, the incidence of such lesions being higher in girls from rural Ireland and Wales than in those from rural England or from urban areas of any of the three countries.

The greater the degree of reaction immediately after Mantoux conversion, the more likely was tuberculous disease to develop: and the greater the degree of exposure to infection, whether in Mantoux-positive or Mantoux-negative persons becoming positive, the higher was the tuberculosis morbidity. The figures were 71 cases among 1,766 Mantoux-negative persons and 124 cases among 7,755 Mantoux-positive persons. When infection occurred among those who had recently become Mantoux-positive, symptoms generally appeared within one year of conversion, whereas in the initially Mantoux-positive group the incidence of tuberculous disease was low in the first year and tended to increase with each year of nursing experience.

The prognosis of the minimal lesion is always a source of anxiety to those treating tuberculosis: it is, therefore, of interest that of 68 cases found on entry to the survey 51 per cent. proved to be progressive and 49 per cent. retrogressive or stationary: and of 97 cases arising after entry and observed for two and a half years 45 per cent. became active, 28 per cent. showed evidence of spread without symptoms, and 27 per cent. were non-progressive. Thus it is evident that the majority of such lesions are progressive.

The whole report gives a wealth of information about the epidemiology of tuberculosis, and will well repay study by all industrial medical officers, who might play an important part in the prevention of this highly preventable disease. *K. M. A. P.*

SAFETY RULES FOR USE IN CHEMICAL WORKS: PART 1—MODEL RULES

(Issued by the Association of British Chemical Manufacturers. London. 1947. Third Edition. Price 7*s.* 6*d.*)

This book presents a summary of the precautions to be taken in working with dangerous materials, and also much information on the principles of good management. The Council of the Association regards it as essential that safe working conditions shall keep pace with technical improvements, in order that the industry shall offer attractive and congenial employment. The rules incorporate the various changes in legislation, and it is stressed that, although they are divided into sections for convenience, they must be read and observed as a whole. The necessary references to the Factories Act and relevant regulations are given in the text of the rules.

Section I sets out general rules for the conduct of work in factories and the establishment and supervision of working conditions. It is highly desirable that all these rules should be adopted in new chemical works and plants and in all works which are being rebuilt or extended. Sections II, III, IV, and V set out rules for the design, operation, and maintenance of plant involving risks from fire and explosion, gas, fume, or dust, and corrosive and deleterious substances. The scope of the rules is comprehensive. Section VI gives rules for fire protection.

The provision of an industrial health service is covered by the rules in Section VII. It is recommended or required that a medical officer should be appointed and that he should be given the fullest information concerning the hazards to be encountered. This recommendation, together with pre-employment and periodic medical examinations and the provision of medical departments, with nurses and adequate numbers of well-trained first-aid personnel, constitutes the basis of a medical service in industry.

Rules covering the general provisions for welfare are given in Section VIII, and special rules concerning the employment of women and young persons in Section IX.

The rules and information given in this book are the result of close co-operation and consultation in industry and are obviously based on practical experience. Their importance cannot be overemphasized and the book is wholly excellent and welcome. *A. T. J.*

PHYSIOLOGY OF MAN IN THE DESERT

By E. F. Adolph and Associates

(Dept. of Physiology, University of Rochester. Interscience Publishers, Inc., New York. 1947. Pp. xiii+357, 184 figures. Price 39*s.*)

This stimulating book contains investigations which were carried out by the Desert Unit of Rochester University, partly in the hot room, partly in the Colorado Desert. An enormous amount of experimental data has been compiled by Adolph and his nine associates. Their main conclusion is that life and efficiency in the hot climate depends on the degree of dehydration, which is the overriding factor. The water loss may be 11 litres per day, of which amount nine-tenths may be expended as sweat. If 5 or 10 per cent. of the body weight is lost by dehydration, the loss can be made good quickly and without any lasting ill effects. If the loss of water reaches 20 per cent. it may have done irreversible harm. The water loss is not shared equally by all parts of the body: the blood serum concentrates as much as the whole body. This causes a decrease of the circulating blood volume, the influence of which is severe, as the circulation has to maintain at the same time an abundant flow of blood for cooling purposes. An accelerated pulse rate and increased body temperature are signs of the circulatory strain. An important practical point is the question of "voluntary dehydration." The thirst is usually not strong enough to induce frequent drinking of sufficient amounts, and a chronic state of mild dehydration is therefore common. This condition often impairs working efficiency without being recognized as the real cause. "When fully hydrated, man cheerfully does tasks which he finds distasteful if he is moderately dehydrated and consequently in low spirits." Acclimatization to heat is possible, but acclimatization to dehydration has not been proved. Little attention is paid to chloride metabolism, although here also one might expect changes caused by adaptation.

A number of practical conclusions are drawn which concern clothing, food, and water requirements. They will be of importance not only to future desert rats, but also to those who are responsible for the health of workers in hot environments. The book will be of value to all those who are interested in applied physiology. *H. H.*

DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY

By Hamilton Bailey, F.R.C.S., etc.

John Wright and Sons. Bristol. 1948. Pp. 100. Price 8*s.* 6*d.*)

Owing to difficulties of printing etc. this edition of Mr. Hamilton Bailey's well-known book is appearing in four parts with a paper cover. It is a pity that this method of publication has been necessary, as the unity of the work is destroyed and the paper cover is unlikely to last long in libraries or in a student's hand.

The first part includes chapters on the basic principles of clinical examination and then proceeds to a description of conditions that affect the face, mouth, and head. The illustrations, on which the strength of the book lies, are for the most part excellent and show very clearly the points which Mr. Bailey is anxious to stress. The text is clear and concise, and leaves the student in little doubt as to the meaning.

It is to be hoped that the other parts of this work will soon be published, since the whole work will be of considerable more value than each individual part. This book is very strongly recommended to medical students because they will find clearly and concisely described the essential physical signs of many conditions they will meet with in the out-patient department and in general practice. *E.C.B.B.*

CATALOGUE OF MEDICAL FILMS

(Compiled by The Royal Society of Medicine and the Scientific Film Association. Aslib. London. 1948. Pp. 125. Price 7*s.* 6*d.*)

This is a valuable little publication which, as its name implies, gives a list of the medical films available at the present time. It does more than this, however, because it gives a brief account of two hundred of them; and also gives the running time and information as to whether they are sound or silent, colour or monochrome. To those who use films it should be a very useful work.

K. M. A. P.

BRITISH AND FOREIGN OFFICIAL PUBLICATIONS

MEDICAL RESEARCH IN WAR

Report of the Medical Research Council for the years 1939–1945. Cmd. 7335. (H.M. Stationery Office. Pp. 455. Price 7*s.* 6*d.*).

Adequate comment on the activities of the Medical Research Council during the 1939–45 war is beyond the competence of one reviewer. Few aspects of medicine and science have not been the subject of intensive study by experts. Deriving its money from Parliament, the Medical Research Council has given a lot for a small expenditure. The biggest grant in aid was of £295,000 in 1945. As the Report proceeds, the reader is more and more amazed that so much should have been done and that it should have been done so well; yet at the end he is left with a vague sense of uneasiness. The impressive—very impressive—list of committees tends to suggest that the Medical Research Council is a Colossus which by its power and size, in the absence of wise direction, might overwhelm the solitary research worker. Many, if not most, of the investigations were the result of team work. In war this was inevitable and proper. No one can deny that the Medical Research Council did much to help the war effort. In some theatres of war, campaigns could not have been conducted except for discoveries in preventive medicine described in the present volume. Judgment of the future, like so much in medicine at the present time, depends on personal bias. To an individualist the outlook for peace is tinged with sadness. The easy-flowing language describes successes which might easily come to be thought of as embracing all research. Some evidence that there is a place for the individual worker and individual failure would give a greater sense of intellectual freedom. The problem poised by the present survey is how to combine the ideas of the individual and the application of the team. As the State assimilates more and more to itself, potential beneficiaries to medicine will become fewer and fewer. To ponder on the future is not to criticise past activities reviewed in this Report. Ideas are delicate, easily dimmed by needless exposition. The very wide field covered by the present Report demonstrates too clearly the power concentrated in the Medical Research Council. If the nation ever comes to expect results from research, a worse censorship of ideas and progress will arise than was ever exerted by the medieval Church. Evidence in the present Report that the Medical Research Council has made, and will make, lavish grants to individual workers is very welcome.

War presents a greater challenge to medicine than to other sciences. Kindliness and love of men are assaulted by patriotic motives. A quotation from the Council's 1938 Report, a prophetic forecast of what was to come about, reminds the reader that "If a strict comparison were made between what science has done to increase war mortality and what medical science has done to lessen these lethal effects, there is good reason to believe that the latter would be an easy winner. No man with any knowledge of the history of disease in relation to war would ever say that science is wholly given to the forging of instruments of destruction." That claim, for it is a claim, was fully justified by the work described in the Report.

If a British soldier, wounded in North-west Europe in 1944–45, came into medical hands, his chance of survival was about 98 per cent., and of being sufficiently fit on recovery for a wide range of civil jobs, about 84 per cent.

Efficient organization of medical services would not have achieved this result unless the ideas underlying treatment were based on firmly established scientific fact. The greatest contribution of the Medical Research Council was not to the therapeutic aspect of medicine and surgery. The Report, with greatly commendable emphasis and precision, points out that in war the first object of medicine is the maintenance of health. The second is the succour of the wounded and sick, and the third object the promotion of the efficiency, comfort, and safety of fighting men. (What a pity that the Council has caught that horrible word "personnel.") A purist might take ethical objection to part of the last object.

At the beginning of the war research was directed towards the solution of urgent pragmatic problems. Even then, much fundamental knowledge was accumulated and it will bear fruit in later years. The story of penicillin is fascinating, and even more mundane aspects of medicine—such as the control of louse infection and the study of army rations—are not untouched by romance. The very effective control of infectious disease during the war was based partly on previous work (for example, active immunization against tetanus) and partly on work initiated and developed during the war. The discovery, development, and manufacture of the cotton rat vaccine against scrub typhus equal in importance the discovery of penicillin. Indeed, many items described in the present survey deserved to be filmed, if only to remind our allies, transatlantic and elsewhere, that Great Britain originated all the new concepts in medicine during the war.

The most disappointing section of the Report is entitled "Health Research in Industry." Perhaps this is because no member of the Council during the war was primarily interested in this branch of medicine. Only twenty-three pages (including fourteen devoted to accounts of special units) are occupied by this section. Many of the studies of human efficiency undertaken for the Services have an application to industry. Very little of the work on health in industry was new. Most of it can be described as the elaboration and propagation of facts which have been known for many years. In this field, only towards the end of the war does the Medical Research Council seem to have realized the need for continuity of work by first-class investigators.

At the London Hospital, under the wide label of industrial medicine, investigations into toxicological problems and industrial disease were conducted. Accounts of work on dust in steel and iron foundries, aluminium dust, bagasse dust, poisonous metals, flourides, arsenic, and vibrating tools, have already

been published. Phosphine was found to be non-toxic to the blood-forming system. Workers at the London School of Hygiene devoted themselves to problems of hygiene (ventilation, warmth measurement, dust sampling, and lighting). The most interesting work, with the greatest promise for the future, was conducted at the Applied Psychology Research Unit at Cambridge. Much information was collected on selection, and on the behaviour of the human mind under varying conditions of stress and confusion. The work on display and control, started under the direction of Craik (who most unfortunately was killed in a street accident in 1945) has special application to industry. Industrial psychology, particularly the cause of absenteeism, was studied at Manchester.

The mode of infection of injuries occurring at work was investigated at the Birmingham Accident Hospital. Most infection of wounds of the hand are due to *Staphylococcus aureus* and *Streptococcus pyrogenes*, the former entering at the time of injury and the latter later in the history of the wound.

The Report is itself a brief review of activities varying from investigations into high-altitude flying to the conservation of human milk. Unless another review of the same size is to be written, the majority of the activities undertaken by the Medical Research Council cannot even be mentioned. As an account of what can be accomplished under the difficulties of war the Report is unique; as a list of different specialist subjects within the purlieu of medicine, it cannot be surpassed.

T. A. Lloyd-Davies.

A REVIEW OF THE LITERATURE RELATING TO AFFECTIONS OF THE RESPIRATORY TRACT IN INDIVIDUALS EXPOSED TO COTTON DUST

By B. H. Caminita, W. E. Baum, P. A. Neal, and R. Schneiter

(U.S. Public Health Bulletin No. 297. Washington, D.C. 1947. Pp. 86. No price given.)

This review gives an account of all processes of the cotton industry, from the farm to the finished article when it leaves the factory. These include harvesting, ginning, baling, grading, bale-breaking, carding, combing, spinning, and weaving. The dangers of respiratory disease are greatest in ginning, bale-breaking, and carding. Since 1827, thirty-six surveys of the health of cotton workers in various countries have been carried out. They show that upper respiratory-tract affections, ranging from chronic irritation of the nose and throat to bronchitis complicated by asthma or emphysema, are particularly common among those with the heaviest exposure to cotton dust. These occupational diseases of cotton workers can be divided into four groups: mill fever, byssinosis, weaver's cough, and a disease which the authors believe is related to *Aerobacter cloacae*, a gram-negative, non-sporulating, rod-shaped organism.

Mill fever is characterized by upper respiratory irritation, cough, chills, fever, and at times nausea and vomiting. Onset of symptoms occurs usually in five or six hours, often on Monday after absence from work during the week-end, and hence it is sometimes called "Monday fever." It clears rapidly on removal of the patient from the dusty environment. Tolerance of the dust develops after a few days. Acclimatization may be limited, so that exposure to a concentration of cotton dust higher than that usually encountered may result in recurrence of symptoms.

Byssinosis is the late result of many years of mill fever. The Byssinosis Act (1940) lays down twenty years' employment in a cotton factory as being necessary before compensation can be granted. The disease is characterized by chronic bronchitis complicated by emphysema and, in the later stages of some cases, asthma. Respiratory irritation, cough, and progressive dyspnœa occur, and some subjects develop right heart failure. Radiographs show only emphysema and slight fibrosis.

Weaver's cough occurs among workers, both old and new, who handle mildewed yarn; examination of the dust revealed *Penicillium*, *Mucor*, *Aspergelli*, and numerous other fungi. The symptoms consist of constriction of the chest, mild dyspnœa, fever, cough, and aching of the limbs, back, and head. Onset usually occurs in four or six hours, and there is rapid improvement in from twenty-four to forty-eight hours after removal from the source of dust.

Exposure to the dust of low-grade stained cotton has been described by the authors of this review as giving rise to an illness which they consider to be due to *Aerobacter cloacae* endotoxin. Both old and new personnel are affected. Headache, generalized body aches, fever, nausea, vomiting, substernal discomfort, and upper respiratory irritation are the usual symptoms. Onset occurs in from one to six hours, while rapid improvement results in from twenty-four to forty-eight hours after removal from the offending environment.

Though the four diseases are described, it seems probable that mill fever and byssinosis are merely stages of the same condition; and weaver's cough and the illness said to be due to *Aerobacter cloacae* are at least diseases which resemble one another closely. It would also seem as though these diseases are closely allied to those which attack workers inhaling the dust of other plant products such as grain, flax, hemp, jute, and bagasse.

The report ends by stating "that investigation of dusts of plant origin from the standpoint of health hazard has hardly been initiated." This is emphatically true of cotton dust. There is need for engineering studies to determine degree of dust exposure and the factors governing dust production in the cotton industry, for complete data on the chemical and physical properties of the dust, for compilation of mortality and morbidity statistics in cotton operatives, and for experimental work on the mechanism of the production of the various disease entities associated with the inhalation of cotton dust.

K. M. A. Perry.

HEALTH OF ARC WELDERS IN STEEL SHIP CONSTRUCTION

(U.S. Public Health Bulletin No. 298. Washington, D.C. 1947. No price given.)

The fact that arc welding became very important during the war has led to this report on the health of welders in steel ship construction. It is based on a survey carried out in 1944 on 4,650 men and women working in seven shipyards on the Atlantic, the Mexican Gulf, and the Pacific coasts. The fume to which the workers were exposed was analysed. It was highest in the most confined welding spaces, but it contained more than 30 mg. of ferric oxide per cubic metre of air for all welding locations and more than 15 mg. of zinc oxide per cubic metre in several. The fume consisted mostly of ferric oxide 50 per cent., titanium dioxide 15 per cent., silica 8 per cent., and a mixture of acid soluble metals such as magnesium, calcium, aluminium, manganese, chromium, copper, and sodium. More than half the samples of gas were found to contain fewer than five parts per million of nitrogen oxide.

Since the length of exposure was short, welders siderosis was found in 61 cases only (3 per cent.). Other diseases found in the group included metal-fume fever, chiefly among men working on galvanized metal and piping. Conjunctival irritation was prevalent and, though acticin conjunctivitis was found infrequently, many workers reported having been affected at some time in the past. Nasal congestion, pharyngitis, and upper respiratory symptoms were more prevalent among welders who used tobacco than among those in a control group. There were 371 (8·1 per cent.) shipyard workers who showed evidence of calcified primary tuberculosis, while the incidence of reinfection tuberculosis was 1·3 per cent.; possibly a selective influence kept people with tuberculosis away from welding. Rheumatic heart disease was found in 1·6 per cent. of the male shipyard workers, and the incidence of arteriosclerotic hypertensive heart disease was 5·4 per cent. in white male welders compared with 17·9 per cent. in a similar group of non-welders. As welding fume may potentially produce anæmia, full blood examinations were carried out, but the result showed no difference between welders and non-welders. However, there was some evidence to suggest that people doing galvanized welding and exposed to zinc fume are more likely to have abnormal sedimentation rates than those not so exposed; this sign may be a prodrome of zinc chill.

Slag burns or scars were characteristic occupational stigmata. They were most commonly observed on the antero-lateral aspect of the elbow just lateral to the cubital fossa. Right-handed welders showed the lesion on the left arm, left-handed welders on the right. They were also found around the ankles, along the belt line of the abdomen, and in the episternal region. The burns were often in a stage of indolent ulceration showing a dirty granulating base. A recent small burn often looked rather like a doughnut, for the lesion was a ring of vesiculation enclosing a tiny area of seared skin. Dressings were not often applied, and severe secondary infection was rare. These burns were commonest in the most experienced welders doing overhead work.

K. M. A. Perry.

ABSTRACTS

(This section of the JOURNAL *is published in collaboration with the two abstracting Journals, Abstracts of World Medicine, and Abstracts of World Surgery, Obstetrics, and Gynæcology, published by the British Medical Association. The abstracts are divided into the following sections: toxicology; industrial physiology; industrial lung disease; industrial dermatitis; accidents and orthopædic surgery; industrial ophthalmology; environment; general.)*

TOXICOLOGY

Further Experience with the Range Finding Test in the Industrial Toxicology Laboratory. SMYTH, H. F., and CARPENTER, C. P. (1948). *J. industr. Hyg.*, **30**, 63.

This paper is an extension of one published in 1944, which indicated the magnitude of some of the health hazards due to new chemicals. Most of the tests were carried out on rats, which were used in groups of 6 at dosages differing in a ratio of 10 (or less). In the tests on subacute oral toxicity now described doses were administered to groups of 10 rats for 30 days. The sample was incorporated in a diet of 1,000 g. ground whole wheat, 500 g. dried milk, and 20 g. iodized salt. Three or four dosage levels differing by a ratio of 2 or 4 were administered. The criteria of injury were the effects on growth, appetite, fatality rate, and the micropathology of liver, kidney, and other organs. Dosages were selected so as to allow at least one group of rats to survive without apparent injury. An elaborate table of the results obtained with 29 chemicals is given. A second table records the effects of 36 chemicals in respect of oral toxicity in rats (single dose), penetration of rabbit skin, inhalation of vapour by rats, and eye injury from fluid. In the skin absorption tests a 1-day rubber cuff was applied to rabbits. In the yapour exposure-tests concentrations were aimed at which would produce fractional mortality during a 4-hour exposure. The concentrations used differed by a ratio of 2. The eye-injury tests have recently been described by the authors in another publication, and are not further referred to. References to the tests on skin sensitization, which were made with 40 chemicals, are likewise omitted, as the results obtained were disappointing and offered no advantages over those carried out on human beings.

H. M. Vernon.

Liver Injury in the Dog following Use of 2-3-Dithiopropinol (BAL). MACNIDER, W. de B. (1947). *Proc. Soc. exp. Biol., N.Y.*, **66**, 444.

In dogs which were given 5 mg. per kilo of BAL intramuscularly twice daily for 4 days the response to the bromsulphalein liver-function test was normal and there was no certain microscopical evidence of liver damage. When the dose was 15 or 30 mg. per kilo twice daily the liver-function test indicated a variable amount of liver damage, and biopsy or necropsy examination of the liver showed fatty degeneration. The damage was most severe with the highest dose and 1 animal died on the fifth day with extensive liver necrosis. It is suggested that heavy metal salts which would combine with BAL might reduce this toxic effect.

Derek R. Wood.

Studies on Experimental Phosgene Poisoning. I. The Pathologic Anatomy of Phosgene Poisoning, with Special Reference to the Early and Late Phases. COMAN, D. R., BRUNER, H. D., HORN, R. C., FRIEDMAN, M., BOCHE, R. D., MCCARTHY, M. D., GIBBON, M. H., and SCHULTZ, J. (1947). *Amer. J. Path.*, **23**, 1037.

This careful study of experimental phosgene poisoning in laboratory animals is mainly concerned with the histological changes in the respiratory organs ; the findings are in close agreement with those of British investigators during the 1914–18 and 1939–45 wars. Shortly after " gassing " extensive emphysema, sloughing of the bronchiolar mucosa, and somewhat variable bronchiolar constriction are observed. Subsequently, peribronchial œdema, pulmonary congestion, and alveolar œdema develop, in that order, with a rapidity and distribution roughly proportional to the severity of the exposure to phosgene. Recovery is primarily a process of resorption of œdema and scarring. A moderate cellular inflammatory reaction accompanies this process and sometimes is so excessive as to be indistinguishable from bronchopneumonia. Residual changes include pulmonary scarring, lobular emphysema, and small irregular areas of atelectasis and bronchitis. There is some reason to believe that similar changes are to be expected in man after " gassing." *G. R. Cameron.*

Studies on Experimental Phosgene Poisoning. IV. The Effect of " Pressure Breathing " on the Pulmonary Edema of Phosgene Poisoning. BOCHE, R. D., BRUNER, H. D., TALBOT, T. R., MCCARTHY, M. D., and GIBBON, M. H. (1947). *Amer. J. med. Sci.*, **214**, 612.

This paper records an investigation of the effects of pressure breathing with oxygen at 6 cm. H_2O on dogs poisoned with phosgene. Both inspiratory and expiratory pressure breathing were used, and adequate numbers of animals in each of the groups were exposed to the treatment for the first 36 hours after " gassing." Mortality was not reduced, and hæmoconcentration, as evidenced by hæmatocrit observations, and extent of pulmonary œdema were not favourably affected. Indeed, certain of the data suggested that such treatment may be harmful ; it is therefore apparent that all such devices must be employed with caution and their adoption as regular therapeutic measures for " gassing " cannot be advocated.

[The authors' discussion of the principles involved in pressure treatment is a model of succinct writing and is worth consideration by all interested.]

G. R. Cameron.

Treatment of Phosgene Poisoning with Thymoxyethyldiethylamine. TRETHEWIE, E. R. (1947). *Aust. J. exp. Biol. med. Sci.*, **25**, 323.

The author had previously shown that thymoxyethyldiethylamine has a favourable effect on guinea-pigs which had been exposed to phosgene. He now describes similar investigations on dogs and mice. The 30 dogs were subjected to concentrations of 161 to 268 mg. per cu. metre of phosgene for periods of 19 to 35 minutes. Half of them were injected with the diethylamine, but the mortality rate in this group was found to be much higher than that in the other dogs used as controls. It appeared that the difference between these results and those obtained in guinea-pigs was due to the diethylamine having a much greater toxicity for dogs. A series of tests was made with mice, which were exposed to phosgene for 10 to 15 minutes. Of the 32 mice treated with diethylamine 17 died, as against 14 out of the 32 untreated mice. No confirmation was therefore obtained of the results of the guinea-pig tests. *H. M. Vernon.*

Methanol Poisoning. (In English.) ROE, O. (1947). *Bull. schweiz. Akad. med. Wiss.*, **3**, 204.

The characteristic signs and symptoms of methyl alcohol poisoning are lassitude, anorexia, nausea, and giddiness, proceeding to epigastric pain and severe vomiting. The pupils dilate and fail to react to light and, in severe cases, amblyopia and amaurosis appear. The patient is confused and comatose ; shortly before death dyspnœa is replaced by apnœa. These manifestations are typical of acidosis but, because of negative results in experimental animals, the importance of this factor has been questioned. The author in a series of 82 cases found that the prognosis varied with the degree of acidosis present. In 48 severe cases (alkali reserve under 26 volumes per cent.) amblyopia or amaurosis was constantly found. Treatment with bicarbonate according to the nomogram of Van Slyke was " very effective." Ethyl alcohol is a powerful antidote, as shown by illustrative cases, both in preserving normal vision and in delaying the onset of acidosis. The explanation given is that ethyl alcohol prevents the oxidation of methyl alcohol to formic acid, which has a toxic action on the retina. Pronounced degenerative changes were found in the retinal ganglion cells of fatal cases. The author was unable to demonstrate such changes in experimental animals, which do not develop acidosis, and concludes that there are fundamental differences between the actions of methyl alcohol in animals and in man.

[No experimental data are given. The article appears to be an abstract of two other works, references to which are given.] *P. N. Meenan.*

Two Outbreaks of Carbon Disulfide Poisoning in Rayon Staple Fiber Plants in Poland. PALUCH, E. A. (1948). *J. industr. Hyg.*, **30**, 37.

Two severe outbreaks of carbon disulphide poisoning occurred in the viscose rayon industry in Poland, one during the war and one shortly after. Of the 600 workers exposed in one factory during 1941 and 1942, 148 showed carbon disulphide poisoning. Of these 30% suffered from encephalopathy, 52% from marked polyneuritis (especially of the peroneal muscles), and 18% from psychic symptoms such as agitation, hallucinations, depression, and somnolence. The morbidity rate during 1943-4 was probably as great. The spinning machines and desulphuring baths in the factory were located in one room, very close to each other. The general and local ventilation provided was inadequate, and two analyses of the air made in 1943 showed respectively 326 and 451 parts per million (p.p.m.) of CS_2, and 83 and 246 p.p.m. of H_2S; the maximum allowable concentration adopted by the American Standards Association is 20 p.p.m. for both gases. In a second factory, tested in 1945, 220 workers were employed in staple fibre operations, the spinning machines and desulphuring baths being again in one room. The general and local ventilation systems were damaged during the war, the exhaust system showed fundamental faults of construction, and the machinery was in very poor condition. Numerous analyses of the air were made in 1946, and they showed a maximum of 370 p.p.m. of CS_2 near the desulphuring baths, and one of 125 p.p.m. near the spinning machines. The maximum for H_2S was 65 p.p.m. When these facts became known to the management alterations and

improvements were carried out, with an immediately favourable effect on the health of the employees.

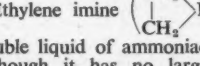
H. M. Vernon.

Chronic Carbon Dioxide Poisoning. Experimental Studies. MEESSEN, H. (1948). *Arch. Path.*, **45**, 36.

This is a report on the lesions produced in 16 rats, 16 guinea-pigs, 5 rabbits, and 3 dogs exposed to mixtures containing 1 to 26% carbon dioxide in air for periods of 5 to 6 weeks, the oxygen pressure being maintained at normal to prevent anoxia. Degenerative changes were found in the lung alveoli and alveolar ducts where fibrin material from the alveolar walls merged with that from the capillary walls and was covered by chromatin masses arising from nuclear pyknosis. Necrotic cells were scattered throughout the liver lobules and were surrounded by swollen lattice fibrils. Degenerative changes in the kidney were most pronounced in those rats exposed alternately and repeatedly to carbon dioxide and air mixtures, and to normal air. [Carbon dioxide is rapidly lost from the tissues with a return to normal atmospheric conditions.] The tubular epithelium was necrotic, especially in the cortico-medullary zone, with accumulations of calcium which blocked the lumen. Degenerative changes were also demonstrated in the ganglion cells of the one brain (guinea-pig) examined.

E. T. Ruston.

The Acute Toxicity of Ethylene Imine to Small Animals. CARPENTER, C. P., SMYTH, H. F., and SHAFFER, C. B. (1948). *J. industr. Hyg.*, **30**, 2.

Ethylene imine  is a colourless water-soluble liquid of ammoniacal odour boiling at 56° C. Although it has no large technical applications at present, these are likely to be devised. Groups of 6 rats or 6 guinea-pigs were exposed to it in a 10-litre chamber, through which an air flow of 8 litres a minute was maintained. Extreme respiratory difficulty was evident in the animals after 3 hours at a concentration of 25 parts per million (p.p.m.) and death occurred after 8 hours at 50 p.p.m. Prostration developed after exposure for 3 hours at 250 p.p.m., and after 2 hours at 500 p.p.m., death following abruptly. Death was usually delayed, half the fatalities occurring after the third day, and 9% after the tenth day; guinea-pigs were rather more sensitive than rats. Necrosis of the tubular epithelium of the kidney was frequent, the lungs were congested, and the liver showed cloudy swelling. The imine vapour does not readily penetrate the skin for clipped guinea-pigs survived 14 days without symptoms when their bodies were exposed for 4 hours to 4,000 p.p.m. Their heads were allowed to protrude into fresh air through rubber cuffs. Propylene imine is only one-quarter to one-eighth as toxic as ethylene imine, while ethylene diamine and triethyl amine are only one-fortieth to one-hundredth as toxic.

H. M. Vernon.

A Comparison of Acute Toxicities of Ethylene Imine and Ammonia to Mice. SILVER, S. D., and MCGRATH, F. P. (1948). *J. industr. Hyg.*, **30**, 7.

Groups of 20 mice were exposed to ethylene imine for 10 minutes in a 629-litre chamber, while another series of tests of the effects of ammonia were carried out with a 386-litre chamber. Both chambers had a constant air flow of 250 litres per minute. Tables are given showing the mortality rate at each of nine concentrations. The lethal dose of ethylene imine was found to be 3·93 mg. per litre (2,236 p.p.m.) and of ammonia 7·06 mg. per litre (10,152 p.p.m.). At first the imine vapour caused some irritation to the eyes and nose, but the mice quickly appeared normal after they were removed from the chamber. No mice were dead, even at the maximum concentration of 6·1 mg. per litre, but deaths began to occur 24 hours after exposure and continued sporadically during the 10-day exposure period. All deaths were preceded by extreme prostration and complete lack of muscular co-ordination. The mice exposed to ammonia exhibited great excitement; their eyes closed immediately and there was severe irritation of the upper respiratory tract. The animals soon became quiet, and death with convulsions followed. Practically all the deaths occurred during exposure, but the surviving mice recovered rapidly after removal from the chamber. Evidently the physiological action of ethylene imine is quite different from that of ammonia.

H. M. Vernon.

Tellurium. II. Effect of Ascorbic Acid on the Tellurium Breath. DE MEIO, R. H. (1947). *J. industr Hyg.*, **29**, 393.

The administration of tellurium compounds to animals causes a garlic-like odour in the breath, presumably due to the formation of $Te(CH_3)_2$. The effect is very variable, and tests made on a group of 13 men and 7 women showed that the administration of 1μg. of sodium tellurite in some cases caused the odour in 20 minutes, whilst in other cases it was necessary to increase the dose to 10, 25, and even 50 μg. in order to obtain a similar effect. A much larger dose of elementary tellurium than of tellurite is necessary to produce the garlic odour. Experiments were made on rabbits with radioactive tellurium, the amount present in expired air being measured with a Lauritsen electroscope. Intraperitoneal injection of 20 mg. of ascorbic acid 20 to 30 minutes before intravenous injection of 500 μg. of tellurium per kilo (as sodium tellurite) reduced the amount of tellurium expired to a fourth or fifth of that shown by most of the controls. Oral administration of 100 μg. of tellurium (as sodium tellurite) to human beings produced a strong garlic odour in the breath, but in 2 cases out of 3 the odour disappeared after the administration of 10 mg. of ascorbic acid per kilo body weight. Also when 4 plant workers exposed to tellurium dust were given 750 mg. of ascorbic acid 3 times daily the odour was considerably reduced or completely abolished. The ascorbic acid probably acts by reducing the tellurite to elementary tellurium, thereby decreasing the formation of $Te(CH_3)_2$.

H. M. Vernon.

Tellurium. III. The Toxicity of Ingested Tellurium Dioxide for Rats. DE MEIO, R. H., and JETTER, W. W. (1948). *J. industr. Hyg.*, **30**, 53.

In order to test the effects of tellurium dioxide on rats three pairs of rats were fed on rat food with which respectively 375, 750, and 1,500 parts per million (p.p.m.) of tellurium dioxide had been thoroughly mixed. The rats receiving 1,500 p.p.m. died after 24 days, and those receiving 750 p.p.m. were killed after 86 days. The other pair were alive and well after 128 days, but their weight was 17% less than that of the control rats; this must have been due largely to their reduced food consumption. The rats on 750 p.p.m. of tellurium put on scarcely any weight during the time the test lasted, while the rats on 1,500 p.p.m. rapidly lost weight. These results are entirely different from those obtained by De Meio on the toxicity of the element tellurium, when all the rats survived. In all of the rats in the present series

there was a garlic-like smell of the breath within the first 24 hours, and it remained throughout the experiments. Marked œdema and swollen and reddened digits were observed in the rats given 750 and 1,500 p.p.m. of tellurium, together with a certain degree of paralysis of the hind limbs. There was an increased loss of hair, compared with the controls. On microscopical examination of the tissues the principal changes were found in the liver and kidneys, although minor degenerative changes were irregularly seen in other organs. The tellurium was evidently narcotizing to hepatic parenchyma and the tubular epithelium of the kidneys. In the 2 rats receiving 1,500 p.p.m. of tellurium the major factor causing death was acute bronchopneumonia, and there were moderately severe liver lesions leading to confluent necrosis, while some of the kidney tubules showed complete cellular disintegration. *H. M. Vernon.*

The Toxicity and Narcotic Action of Mono-chloro-mono-bromo-methane with Special Reference to Inorganic and Volatile Bromide in Blood, Urine and Brain. SVIRBELY, J. L., HIGHMAN, B., ALFORD, W. C., and von OETTINGEN, W. F. (1947). *J. industr. Hyg.*, **29**, 382.

Monochloromonobromomethane (CH_2ClBr) is of interest as a potential agent in fire extinguishers. The concentration required to kill 50% of exposed mice in 8 hours was determined by keeping them with the substance in a ventilated bell-jar of 15 litres capacity, and by measuring the ventilation rate and the weight of substance vaporized. This concentration was found to be 1·58 mg. per litre (2,990 parts per million; p.p.m.), considerably lower than the corresponding figures for dichloromethane and carbon tetrachloride. The acute toxicity of CH_2ClBr was also studied by oral administration, the mice being fed with various doses of the substance dissolved in olive oil. It was found to be approximately 4·3 g. per kilo. The tests showed that the substance is a narcotic agent of moderate intensity but of prolonged duration.

In the experiments on the chronic toxicity of CH_2ClBr, 2 dogs, 3 rabbits, and 20 rats were exposed to a concentration of 1,000 p.p.m. in a 410-litre chamber for 7 hours daily on 5 days a week for 14 weeks. All the animals remained in excellent health. An equal number of animals served as controls. No significant changes were observed in the blood cells and hæmoglobin concentration of the dogs and rabbits, or in the liver function of the dogs as revealed by the bromsulphthalein excretion test or by examining for urobilinogen in the urine. Inorganic bromides tended to accumulate in the organism, though volatile bromide did not. At the end of the 14-week experiment the blood and the brain of the animals were analysed. The brain of dogs, rabbits, and rats was found to contain 21 to 61 mg. of inorganic bromide per 100 g. of tissue, whilst the volatile bromide ranged from 0·35 to 0·82 mg. On the other hand the blood contained 161 to 359 mg. of inorganic bromide per 100 g. and 5·2 to 9·1 mg. of volatile bromide. Histological examination showed that CH_2ClBr might cause temporary degenerative changes in the liver, but, in contrast to carbon tetrachloride, no cirrhosis was seen. *H. M. Vernon.*

Mercury Exposures in Dry Battery Manufacture. WILLIAMS, C. R., EISENBUD, M., and PIHL, S. E. (1947). *J. industr. Hyg.*, **29**, 378.

One of the outstanding electrochemical developments during the 1939-45 War was the Ruben cell, an alkaline primary dry battery. It derives its E.M.F. from a reaction in the course of which mercuric oxide is reduced to metallic mercury, and it consists of an amalgamated zinc anode, a mercuric oxide and graphite pellet cathode, and an alkaline electrolyte, all placed in a steel container. In 1945 several plants produced 1,500,000 cells daily for war uses, and there is likely to be a large peacetime demand for the cell. During the war the dust exposures in the plants were high, as it was difficult to obtain ventilation equipment, and respirators were used for protection. Air samples taken at one plant with the electrostatic precipitator showed concentrations of 0·07 to 0·42 mg. of mercury per cubic metre of air, half of the sample exceeding the tolerance dose of 0·1 mg. per cubic metre. In two plants concentrations of mercury vapour in the neighbourhood of the amalgamating operations gradually fell from averages of 0·66 to 0·8 mg. to 0·29 to 0·41 mg., with better ventilation and other precautions such as the proper construction of the tables on which amalgamating was effected. Experience showed that it is much easier to control exposure by keeping the mercury off the floors of the plant than by cleaning up a contaminated area. A detailed list of the suggested controls is given.

H. M. Vernon.

The Determination of Lead in Freshly Voided Urine. A Rapid Screening Test. CHOLAK, J., HUBBARD, D. M., and BURKEY, R. E. (1948). *J. industr. Hyg.*, **30**, 59.

As a rule chemical laboratories in hospitals and industrial establishments are not equipped to carry out reliable determinations of lead in biological material. The authors describe a rapid method for determination of lead in freshly voided urine. It requires a minimum of equipment and manipulation, but it does not distinguish between lead and bismuth. The value of the method is greatest in investigations of occupational lead exposure in groups of individuals. A single determination can be made in 20 to 30 minutes. [The details of the test can be described here only in outline, and the original paper should be consulted for full information.] A 40-ml. sample of the urine is mixed in a 50-ml. centrifuge tube with 1 ml. of "precipitating solution" (of calcium chloride and di-ammonium phosphate) and 4 drops of ammonium hydroxide (sp. gr. 0·900). It is centrifuged for 5 minutes, the supernatant liquid is decanted, the precipitate is washed and dissolved in HCl, and the volume made up to 40 ml.; 50 ml. of chloroform is added, the mixture is shaken, and the chloroform layer is discarded so as to remove organic substances. Then 30 ml. of a "buffer solution" (containing citric acid, potassium cyanide, sodium sulphite, and dithizone) is added, and the mixture shaken with 10 ml. of chloroform. The density of transmission of the chloroform solution is measured with a Beckman spectrophotometer at 510 mμ. The photometer readings are evaluated from a calibration curve previously prepared with known amounts of lead solution. Samples of the results obtained with this method and that of Bambach and Burkey are quoted; they show fairly satisfactory agreement.

H. M. Vernon.

Control of a Lead Hazard in the Brass Foundry Industry. HAMLIN, L. E., and WEBER, H. J. (1947). *J. industr. Hyg.*, **29**, 367.

Analyses of over 15,000 spot samples of urine and 1,000 blood specimens of the workers in 6 brass foundries were made over a 3-year period. The polarographic method of analysis was used, and the conclusion was drawn that intoxication rarely occurred unless the rate of excretion was over 300 μg. of lead per litre of urine, and that values up to 200 μg. had no definite significance. In all, 1,103 employees were tested, and the air in the

foundries contained on an average 11·4 μg. of lead per 10 cubic metres before various control methods were adopted and 5·2 μg. after their adoption. Before control 19% of the men had 300 μg. of lead or over in their urine; after control only 2·7% reached this level. There were 32 cases of intoxication a year before control and only 6 after it. There was a close correlation between the urinary lead excretion rates and the amount of lead in the air. The usually accepted maximum allowable concentration of 1·5 mg. of lead per 10 m³. appears to be unwarranted, and the limit of 5 mg. per 10 m³. which investigators in Great Britain proposed is probably closer to the correct value. *H. M. Vernon*

Mass Poisoning by Tetraethyl Lead. (Zbiorowe zatrucie czteroetylkiem olowiu.) PASZKOWSKI, S. (1947). *Polsk. Tyg. lek.*, **2**, 1168.

Lack of industrial supervision, black-market activities, and smuggling seem to be responsible for the increasing frequency of cases of tetraethyl lead poisoning in Poland after the war. Several cases—some fatal—have occurred in villages and among individuals engaged in furniture polishing. The author describes 3 cases that were all diagnosed at first as typhus. General malaise without rise in temperature lasted for several days, with increasing restlessness, talkativeness, confusion, and visual and auditory hallucinations amounting to a state of severe delirium. Ataxia, hyperkinesis, and choreiform movements were also seen. Two patients were employed in the same workshop and the third came from a district where similar cases were reported. Chemical analysis of the fluid used for polishing furniture revealed 60% of tetraethyl lead. One patient recovered and 2 died. [No post-mortem reports are given.] *J. Leyberg.*

Proteinuria and Kidney Injury Among Workmen Exposed to Cadmium and Nickel Dust. Preliminary Report. FRIBERG, L. (1948). *J. industr. Hyg.*, **30**, 32.

Workmen employed in a factory devoted to the manufacture of alkali storage batteries complained of increased fatigue. Battery electrodes consist of hydrate of nickel and cadmium oxide and in the production these constituents form a fine dust; air analyses indicated the presence of 0·003 to 0·9 mg. of cadmium and 0·01 to 0·7 mg. of nickel per litre of air. The employees at the factory were separated into a group of 19 men who had worked at the factory for under 3 years (average 1 year), and 1 of 19 men who had worked for 8 to 32 years. The men of this latter group were more subject than the others to fatigue, irritability, increased thirst, and shortness of breath; 12 suffered more or less from the loss of sense of smell; 18 had proteinuria. A weak Esbach test was obtained in 2 cases, while the Heller test gave positive reactions in 14, and there was precipitation with 25% trichloroacetic acid in 4. Other tests seemed to indicate that the protein contained at least three components. Of the 17 patients tested with a spirometer 15 had emphysema, but *x*-ray examination revealed this in only 4 cases. *H. M. Vernon.*

Changes in the Exocrine Parts of the Pancreas in Experimental Chronic Nickel Poisoning. (Über Veränderungen im exokrinen Teil des Pankreas bei experimenteller chronischer Nickelvergiftung.) FISCHER, H., and HUBER, P. (1947). *Vjschr. naturf. Ges. Zürich*, **92**, 165.

Nickel in the form of sulphate, or as a salt of α-oxybenzylphosphinic acid, was injected subcutaneously into cats. Injections of 1 to 7 mg. were given over a period of 2 to 7 months amounting altogether to 103 to 657 mg. Each injection induced cyclic changes in the pancreas. There was a rapid extrusion of secretion from the acinar cells resulting in distension of the lumen and ducts of the gland. In many acinar cells fresh zymogen granules were elaborated in association with the Golgi apparatus. Often, however, individual cells, acini, or whole lobules underwent degeneration after 2 or 3 days. After the excretion of the nickel, regenerative processes resulted in a gradual restitution of the pancreas to complete functional activity. It is suggested that the rapid reaction of the pancreas to nickel injections is an indication of a special affinity of this organ for the metal.

R. J. Ludford.

Toxicological Studies on Laboratory Animals of Certain Alkyldinitrophenols Used in Agriculture. SPENCER, H. C., ROWE, V. K., ADAMS, E. M., and IRISH, D. D. (1948). *J. industr. Hyg.*, **30**, 10.

The dinitrophenols are used extensively for the control of insects, fungi, and weeds. As regards: (*a*) 2,4-dinitrophenol, many reports on its effects in man and animals have been made, but there is little information about the toxicity of (*b*) 4,6-dinitro-*o*-cresol, (*c*) 2-*sec*-butyl-4,6-dinitrophenol, (*d*) 2-cyclohexyl-4,6-dinitrophenol, and (*e*) the cyclohexyl-4,6-dinitrophenol compound with dicyclohexylamine. The effect of these substances in 3% solution in ethanol on the skin of rabbits was tested by making 20 applications on the ear and 20 applications on the shaven abdomen over 4 weeks. Not one of the dinitrophenols tested is appreciably irritating to the skin. On the other hand, tests with rabbits and guinea-pigs showed that some of the compounds were readily absorbed through the skin in lethal amounts; (*c*) was the most toxic, even 0·5 g. per kilo sometimes causing death. Substances (*b*) and (*a*) were rather less toxic, while (*d*) and (*e*) were not absorbed to an appreciable extent. Tests on rats showed that all the substances investigated had a fairly high order of acute oral toxicity. When administered in a single dose by stomach tube the lethal dose of (*c*) was 0·06 g. per kilo; of (*b*) 0·05 g. per kilo; of (*a*) 0·10 g. per kilo; of (*d*) 0·18 g. per kilo; and of (*e*) 0·60 g. per kilo. When male rats were fed for 6 months on a Sherman diet containing 0·01% of (*c*), 0·01% of (*b*), 0·02% of (*a*), 0·05% of (*d*), and 0·05% of (*e*), no appreciable ill effects followed, as shown by the growth curves, blood counts, blood urea-N, organ weights, and histopathological examinations.

In view of the frequency with which (*a*) produces cataract in man, many attempts had been made on laboratory animals but without success until Robbins found that cataracts formed very quickly in ducklings and chicks given a diet containing the sodium salt of 2,4-dinitrophenol. The present investigators made extensive tests with this and other dinitrophenols on 5-day-old white Pekin ducklings; within 24 hours all of the ducklings fed on a diet containing 0·25% of the sodium salt of (*a*) developed bilateral cataracts. Similar cataracts were produced in 24 hours by a diet containing 0·25% of (*b*). Ducklings on a diet containing 0·25% of (*c*) died within 3 days without developing cataracts, while half of those on a diet containing 0·03% died within 5 days, and 1 in 5 had cataracts. No cataracts were observed in ducklings fed on diets containing (*d*).

It is evident that (*b*) and (*c*), because of their ready adsorption through the skin, present many problems in safe handling. Strict precautions must be observed to avoid contact of the skin with their liquid concentrates if these are greater than 5%. There is a risk to health in

the inhalation of dusts or sprays, the risk from (*d*) and (*e*) being much less serious than from (*b*) and (*c*).

H. M. Vernon.

INDUSTRIAL PHYSIOLOGY

Physiological Characteristics of Flight Personnel. HURTADO, A., ASTE-SALAZAR, H., MERINO, C., VELASQUEZ, T., MONGE, C., and REYNAFARJE, C (1947). *J. Aviat. Med.*, **18**, 406.

A study was made of 50 flying personnel of a commercial line in South America making frequent flights at 9,000 to 20,000 ft. for periods averaging several hours a day. Continuous flow oxygen was provided by a tube held in the mouth and was generally used above 12,000 ft. All were Americans normally living at sea-level, all but 2 in the third or fourth decade of life. Estimations were made of total pulmonary capacity, including complemental and reserve volumes and residual air; hæmoglobin concentration of blood; hæmatocrit value; size, shape, and hæmoglobin content of erythrocytes; leucocyte and reticulocyte count; acid-base balance of blood; serum bilirubin concentration; and transverse diameter of the heart measured radiographically.

The values obtained were compared with corresponding values for normal subjects permanently resident at sea-level, and for those who had been resident at altitudes of 12,000 ft. or more for a considerable period. The comparison showed that there was no statistically significant difference between the values obtained for the subjects under study and those for persons permanently resident at sea-level, except for a slight rise in residual air volume in the flying personnel. No evidence could be obtained from the data of a compensatory adjustment to an intermittently lowered oxygen tension.

D. A. W. Edwards.

The Relationship Between Alveolar Air Oxygen Tensions and Arterial Blood Oxygen Saturations in Man During Work at Altitude. GEMMILL, C. L. (1947). *J. Aviat. Med.*, **18**, 483.

This work deals with the pressure gradient of the respiratory gases across the pulmonary membranes in conditions of anoxia and of physical exertion.

The 4 subjects studied carried out exercise either in the decompression chamber or while breathing air-nitrogen mixtures. The work load was varied from 1,555 to 4,980 ft.-lb. per minute, and the simulated altitude from sea-level to 19,100 ft. The alveolar oxygen tension was determined on an expiratory sample during the rest periods, and on an inspiratory sample when the subject was working. Arterial oxygen saturation was estimated just before the alveolar air sample was taken. Three alveolar air samples at minute intervals were obtained while the subject at rest breathed atmospheric air; then, while the subject breathed an air-nitrogen mixture (or air at a simulated altitude in the decompression chamber) 3 more readings at minute intervals were taken in each of three conditions: (1) at rest, (2) during work, and (3) during recovery following the work. Lastly, three samples were again collected while the subject breathed atmospheric air. A preliminary investigation had shown: (1) that oxygen saturation of blood did not fall significantly after the first 3 minutes of breathing an air-nitrogen mixture; (2) that during work in similar conditions the greatest fall in saturation occurred within 3 to 4 minutes, although a gradual fall persisted for a further 3 minutes.

The results obtained in the third minute of anoxia during rest and in the third minute of the work period were compared with a standard oxygen-hæmoglobin dissociation curve (*p*H 7·4). This comparison shows a reasonably close agreement during rest, but during work, although the alveolar oxygen tension falls, there is a greater decrease in arterial blood saturation, so that the point does not remain on the standard dissociation curve. An example at 12,000 ft. shows a difference during work of 21 mm. Hg. Determinations of alveolar carbon dioxide show that the change in tension during work would not be sufficient to shift the curve significantly. Also it is considered that any changes in the temperature of the subject would not account for the results. The findings therefore indicate a lack of equilibrium between the alveolar and blood oxygen tensions. This effect increases with increasing altitude.

C. B. McKerrow.

The Human Adrenal Cortex in Relation to Stressful Activities. HOAGLAND, H. (1947). *J. Aviat. Med.*, **18**, 450.

In 16 instructor-pilots and 7 test pilots the 17-ketosteroid excretion varied with the percentage time in the air. A diurnal rhythm of 17-ketosteroid excretion has been allowed for in tests. Taking examinations and exposure to extremes of temperature also increased 17-ketosteroid output. Accompanying this enhanced output is an increased diuresis which is not due to a flushing out of steroids by metabolic water. A pursuitmeter was designed, whose operation caused as much stress as close formation flying in bad weather. The time on the target for a skilled operator using this machine declined from 60 to about 30% in 1½ hours whilst his oxygen supply was decreased from room air to approximately 13% in the first 20 minutes. There was a corresponding drop in the operator's lymphocyte count. Army pilots under stress who were taking 50 mg. of pregnenolone daily by mouth excreted about half the amount of 17-ketosteroids that they would otherwise have done. This suggests a sparing action of pregnenolone on the adrenal cortex. Seven of the 16 army pilots previously studied again operated the pursuitmeter whilst taking pregnenolone (50 mg. a day). They showed improvement in their ability to ride the target. Seven civilian students and 6 hospital employees received no benefit from pregnenolone. Of industrial workers, the groups who were under the most stress and those most highly motivated showed the greatest improvement when given pregnenolone. In cases of neuropsychiatric fatigue a general improvement in fatigue symptoms has been found after daily administration of 100 mg. of pregnenolone. After injections of adrenal cortex extract in 5 normal subjects the urinary excretion of cortins, 17-ketosteroids, uric acid, and potassium increased and the lymphocyte count fell.

M. I. Stern.

Effects on Man of High Concentrations of Carbon Dioxide in Relation to Various Oxygen Pressures During Exposures as Long as 72 Hours. CONSOLAZIO, W. V., FISHER, M. B., PACE, N., PECORA, L. J., PITTS, G. C., and BEHNKE, A. R. (1947). *Amer. J. Physiol.*, **151**, 479.

In 6 experiments men breathed recirculated air for periods of 35 to 72 hours in sealed spaces of such size as to provide 500 cu. ft. of air volume per man. Exposures in atmospheres of carbon dioxide concentrations up to 5% and reduced oxygen concentrations as low as 12% did not seriously impair the physical condition and efficiency of the subjects as evaluated by biochemical, physiological, and psychological tests. Minor symptoms

of headache, nasal congestion, and dryness of the throat quickly disappeared when outside air was breathed.

In an atmosphere of 5% carbon dioxide and 12% oxygen healthy men are able to maintain an adequate oxygen pressure in the lungs, blood, and tissues because an increase in respiratory minute volume (hyperventilation) and an increase in pulse rate (circulation) prevent a corresponding reduction in oxygen concentration in lungs and blood despite the decrease in ambient oxygen from 21 to 12%. Consequently, in long exposures to atmospheres of high carbon dioxide content (5%) it is not necessary to maintain the oxygen concentration of the recirculated air at the normal value.

Concentrations of carbon dioxide much above 5% are not well tolerated. This value appears to be a limiting level for healthy young men if exposures are prolonged.—[Author's summary.]

Effect of Prolonged Phosphate Administration on Metabolism of Resting and Working Subjects. (Über die Wirkung länger dauernder Phosphatzufuhr auf den Stoffwechsel in Ruhe und Arbeit.) EHRENBERG, R. (1948). *Dtsch. med. Wschr.*, **73**, 44.

Healthy young soldiers were studied at rest and working on the ergometer before and during a course of "recresal" (Na_2HPO_4, 0·336 g., NaH_2PO_4 0·029 g., excipient, 4 tablets daily); each subject was tested 3 times after a month without recresal. While the men were taking the tablets the total respiratory volume and the volume of oxygen used were 5 to 12% less than during the control period. Measurements were made on 12 convalescent patients receiving the tablets, and 12 convalescent controls who had no phosphate; only the resting respiratory volumes were noted. Over periods of 8 to 25 days the control series showed a reduction in respiratory volume of 6%, in oxygen consumption of 6%; the figures for the test series were 11% and 4% respectively. Treatment with small doses of phosphates increases the efficiency of respiratory exchange in healthy subjects and in convalescents.

[It has been known for years that KH_2PO_4 in doses of 3 to 7 g. will increase considerably the muscular work of which an individual is capable during the 3 to 6 hours after its ingestion. If 50 g. glucose is added the effect is enhanced.] *G. Discombe.*

The Effect of Alcohol and Some Drugs on the Capacity for Work. (In English.) ASMUSSEN, E., and BØJE, O. (1948). *Acta physiol. scand.*, **15**, 109.

Alcohol, caffeine, cocaine, strychnine, and nitroglycerin are used in competitive sports. In the present paper the effect of these substances has been tried in controlled work experiments on normal, non-fatigued athletes. It was found that none of them could increase the ability to perform maximal muscular work, lasting about 15 seconds or about 5 minutes, with the possible exception of caffeine in the longer period. [From the authors' summary.]

Effect of Under-nutrition and Alterations in Diet on the Choline Esterase Activity of Serum. MCCANCE, R. A., WIDDOWSON, E. M., and HUTCHINSON, A. O. (1948). *Nature, Lond.*, **161**, 56.

The activities of the "total" cholinesterase and of the "true" cholinesterase in the serum of groups of German civilians in various nutritional states were determined. In 39 healthy British persons the average activity of the "total" esterase was 80·2 units; in 82 German factory workers 56·7 units; in 45 German civilians attending hospital for nutritional œdema 48·5 units; in 12 German internees with œdema 42 units; and in 9 civilian prisoners 29 units. The authors say this was not due to a decrease in serum protein. The effect of improved feeding was to raise both the "total" and "true" cholinesterase. For example, in 12 prisoners on an improved diet which raised the average weight by 10 kg. there was an average increase in the "total" esterase from 52 to 63 units and in the "true" esterase from 0·8 to 1·0 unit. Again, 19 undernourished German civilians showed a rise from 47 to 75 units in "total" esterase and from 0·9 to 1·0 unit in "true" esterase on an improved diet which increased the weight by an average of 10 kg. This last group lost weight on return to the normal rations and there was a fall in "total" esterase to 55 and in "true" esterase to 0·95. The effect of improved diets on the esterase was not due to the digestion, absorption, or metabolism of fat, for no rise occurred when 6 men were given a supplement of 100 g. of fat for 3 days.

The results suggest that the average level of the enzyme, especially of "total" esterase, is a delicate index of the nutritional state of the German people. [As with most other laboratory methods for detecting malnutrition, a wide range of values is found, so that the tests are of more use for groups than for individuals.] *John Yudkin.*

INDUSTRIAL LUNG DISEASE

The Relation of the Oil Treatment of Floors and Bedding to the Control of Respiratory Diseases Among Naval Personnel. SHECHMEISTER, I. L., and GREENSPAN, F. S. (1947). *Amer. J. Hyg.*, **46**, 376.

The authors used a non-ionic oil base with which was mixed a solution of "roccal," a quaternary ammonium compound (alkyl-3-dimethyl-benzyl ammonium chloride). The resultant emulsion is germicidal, stable, odourless, non-irritating to the skin, and cationic and thus readily adsorbed by textiles which are negatively charged. It is also cheap and can be readily applied to both floors and blankets. Four alternative formulæ are given for suitable oil bases, with test data. An apparatus was designed by means of which the bacterial content of any piece of textile can be estimated.

The practical application of this oil-roccal emulsion was studied for 13 months in a barracks where there were 3,267 men living in the "experimental" side and 3,204 in the "control" side. The decks in the experimental barracks were treated as follows: (1) Free dirt and polish were washed off with soap and water. (2) The floors when dry were swabbed with 20% oil-water-roccal emulsion (5 ml. per square foot). (3) Applications were repeated weekly for 3 weeks, thereafter fortnightly. (4) Dry sweeping was carried out between the applications. Dust samples from the floors were obtained by ordinary sweeping. The bacterial content was determined. Roccal was unnecessary in the oil treatment of flooring, plain emulsion being equally effective. Although the amount of dust was considerably less in rooms with oiled floors, the numbers of β-hæmolytic streptococci present in this dust were similar to those found in dust from untreated rooms. Only 5% of the isolated strains were of Group A.

The blankets belonging to the experimental group were treated as follows. (1) They were laundered and rinsed thoroughly. (2) To each wheel containing 20 blankets, during the last water rinse, 1,500 ml. of oil-base was added. This was sufficient to impregnate the blankets with 3% by weight of oil. (3) When the emulsion had formed, 40% roccal solution was added—170 ml. for 20 olive-drab or 500 ml. for 20 white blankets. After 5 to 10 minutes of agitation the emulsion lost its opalescence and appeared nearly clear. (4) The blankets were hydro-extracted and dried in the routine way. Large numbers of blankets were sampled bacteriologically and compared

with similar numbers of untreated blankets, varying periods of time being allowed to elapse between tests. The tabulated results indicate a sharp reduction in the number of bacteria in blankets after treatment. Treatment by oil alone or roccal alone was not so effective as treatment by oil-roccal emulsion.

The numbers of organisms in the air fell by 22 to 63% when the environment was oiled.

The following facts emerge: (1) Floor dust is not an important reservoir for pathogenic streptococci. The value of oiling lies mainly in dust control. (2) Approximately 20% of the entire population harboured in their throats β-hæmolytic streptococci, a large proportion of which were potential pathogens. (3) In an oiled environment the carrier rate was slightly but significantly reduced. (4) Oiling had no apparent effect on the incidence of minor respiratory complaints. (5) During periods of low incidence of respiratory disease, oiling seemed to cause a slight reduction in the number of cases. No such reduction was found when the general incidence of respiratory disease was high. *T. E. Graham.*

Bagasse Disease of the Lungs. LEMONE, D. V., SCOTT, W. G., MOORE, S., and KOVEN, A. L. (1947). *Radiology*, **49**, 556.

The main incidence of bagasse disease is among workers who open the bales and shred or grind the fibre. Material from one necropsy and one biopsy specimen obtained by lung puncture showed fibroblastic proliferation in the interstitial tissue of the lung, which also included occasional refractile spicules resembling those described in the sputum. Alveolar cells are numerous and large, with "foamy" cytoplasm. Symptoms and theories of ætiology are discussed and it is suggested that the condition may have an allergic basis. Treatment was symptomatic; oxygen was found useful. Detailed reports of 3 cases are given. *L. W. Hale.*

Development of Silicotic Lesions in Workers Removed from Dust Contact. (L'evoluzione delle lesioni silicotiche negli operai allontanati dal lavoro polveroso.) MONTESANO, G. (1947). *Med. d. Lavoro*, **38**, 345.

Nine subjects were observed, 8 of whom had spent a considerable time as rock drillers or in breaking up some kind of mineral. Some had continued and others had long ceased such employment. Contrary to the view once held, the evidence here described, both clinical and radiological, strongly suggests that the lung condition may progressively deteriorate long after exposure to noxious dusts has ceased. In some patients who were clinically and radiologically unaffected when work was given up marked changes were found 4 or 5 years later. The author considers that there is an incubation period which depends on the nature of the dust and the specific susceptibility of the individual, but he cannot define the latter more exactly. In some films a pronounced bronchopneumonic spread was observed a few years after a nodular, and apparently quiescent, silicosis had been recorded. It would appear that the disease process, once begun, is little affected by the individual's continued exposure or removal to other work. For this reason it is not considered practicable or of any medical value to alternate periods of work with periods in which no harmful dust exposure is possible. Those whose condition is complicated by tuberculosis should be permanently excluded from further exposure to dust. The protection of the others is to be sought in improved technical methods of mining and quarrying.
G. C. Pether.

Silicosis in a Quartz Mine. (La silicosi in una cava di quarzo.) MONTESANO, G. (1947). *Med. d. Lavoro*, **38**, 370.

In a quartz mine in which the mineral was 98% pure and in which there was much small-particle dust, nearly a third of 71 men had silicosis. In some cases the disease became apparent after only 3 to 4 months' exposure, and, once established, was rapidly progressive. The clinical findings were at first misleading and did not reveal the extensive lesions already demonstrable radiologically. In this mine the rock was broken up with compressed air drills and no special safety measures were in use. Most of the dust was thrown up by the drills or when explosives were used. Seven patients submitted to detailed investigations had an average exposure of 5½ years, with a minimum of 2½ and a maximum of 9. In 1 the lesions were micronodular, in 3 nodular, in 1 nodular with a tendency to confluence, in 1 massive, and in 1 associated with tuberculosis. All the patients had respiratory symptoms a few years after they began employment. Three years after the author first examined these 7 patients, 5 had had to give up work and 2 had died. *G. C. Pether.*

Observations on the Fixation of Inhaled Mineral Dusts in the Lungs: Experimental Study of Silicosis. (Les conditions de la fixation dans le poumon des poussières minérales inhalées. Contribution a l'étude expérimentale de la silicose.) DELARUE, J., and DÉROBERT, L. (1947). *C. R. Soc. Biol., Paris*, **141**, 1004.

Continuing previous experiments the authors tried to discover whether mineral dusts behaved in the lungs in the same way as certain stains, such as iodized oil, or as some endogenous and exogenous pigments with a specific affinity for certain tissues. Two groups of dogs were used in their experiments. In the first group colloidal silica or powdered quartz or silica was injected into the trachea. This procedure was repeated daily for several days or even for as long as 2 months. In the second group a hypertrophic pneumonic process was first induced by intratracheal injection of B.C.G., and exposure to dust then followed as in the first group.

In animals without an induced pneumonic state killed soon after dust inhalation began the dust particles were found in the intact alveolar cells. If they were killed after a longer period the parenchyma was relatively free but much dust was seen in the hilar glands. In the dogs with induced pneumonia the distribution of the pathological areas was not uniform, but wherever these occurred there was also a marked concentration of dust. The areas of lung without pneumonic changes contained little or no dust. If exposure to dust was prolonged the pneumonic areas were found to contain dust in quantity. One dog had a tuberculous lung before the experiment. This had not been suspected before the necropsy but when the animal was killed 65 days after dust inhalations began there was a marked concentration of silica round the fibrotic areas. One dog died 46 days after exposure to B.C.G. and 34 days after it began to inhale dust. Silica particles were found in the thickened alveolar walls and in the exudates. It appears likely that dusts settle in the lungs according to laws which apply to them all, irrespective of their individual pathogenic attributes. For fixation to occur some antecedent morbid change is necessary, and this will determine the development and characteristics of a pneumoconiosis. Variations in dust diseases in human beings depend more on the antecedent factors than on any specific action of a dust. *G. C. Pether.*

Experimental Lung Changes due to Aluminium Dust. (Über experimentelle Aluminiumstaublungen.) DE MARCHI, A. (1947). *Schweiz. Z. Tuberk.*, **4**, 413.

The symptomatology and pathology of aluminium pneumoconiosis in human beings is described, and experiments on rabbits and guinea-pigs exposed to the insufflation of aluminium dust reported. The symptoms of aluminium pneumoconiosis are not characteristic. Patients suffer from general discomfort, lassitude, sleeplessness, poor appetite, loss of weight, and abdominal pain. Later they complain of pain on breathing, frequent colds, cough and expectoration, shortness of breath, tachypnœa, and tachycardia. Clinical signs include hypertrophic rhinitis and sometimes perforation of the septum nasi. Auscultation of the lungs reveals diminished vesicular breathing, medium and fine rales, and increase of pectoral fremitus. Expansion of the thorax is decreased and vital capacity reduced. Radiographs show increase of the normal bronchial markings with or without mottling, mainly in the middle zone, and emphysema at the bases. There may be enlargement of the heart, increase of the erythrocyte sedimentation rate, and a relative lymphocytosis in the blood film. The development of changes in the lungs has no relation to the length of exposure; only in advanced cases do the symptoms and the reduction of the vital capacity correspond to the histological picture. The latter shows non-specific catarrhal changes in the bronchi, an accumulation of dust cells in the alveoli, hyalinization of the interstitial tissue, and increase in elastic tissue leading to atelectasis.

Anæsthetized animals were treated by insufflation of aluminium dust once or several times at short intervals and observed for 14 months. Three phases could be distinguished; an exudation of leucocytes lasting for from a few hours to 2 days was followed by an increase of monocytic cells. The end phase was characterized by the replacement of the monocytic cells with the formation of granulomatous tissue. The aluminium particles are taken up by phagocytic cells in the smaller bronchi and bronchioli and they set up a continuous chronic irritation. The dust particles are not carried away by the lymphatics or blood vessels.

Franz Heimann.

Pulmonary Disease in Workers Exposed to Beryllium Compounds: Its Roentgen Characteristics. PASCUCCI, L. M. (1948). *Radiology*, **50**, 23.

Thirty-two cases of pulmonary change following exposure to powders containing berryllium are described. The average exposure which occurred in the making of fluorescent tubes and lighting was 18 months, and symptoms arose, on an average, 2 years after the subject left the work. Symptoms generally included shortness of breath, cough, and loss of weight, with some rales and loss of resonance. Lymph nodes were not generally enlarged. There was polycythæmia. A follow-up study revealed that 30% of the subjects had died, 30% were slightly worse or not improved, and 40% had improved. It is as yet too early for final assessment. The lungs show either: (1) a bilateral diffuse granularity, mainly in the middle zones, which has a fine sand-paper texture, or (2) coarse nodular infiltration diffusely scattered through the lung fields, the lesions measuring up to 4 to 5 mm. The first type of lesion is apt to become confluent and then appears to carry the more serious prognosis. The hilar lymph nodes tend to enlarge. The clinical and radiological picture may show remission. In this respect the radiological findings differ from those in pneumoconiosis, with which they otherwise may have much in common, and resemble those in sarcoidosis.

A. M. Rackow.

Pulmonary Changes following Exposure to Phosgene. DURLACHER, S. H., and BUNTING, H. (1947). *Amer. J. Path.*, **23**, 679.

Dogs exposed to phosgene (290 mg. per cubic metre for 30 minutes) often developed consolidation of one or more lobes of the lungs 4 to 9 days after exposure. The involved lobes showed obliterative bronchitis together with a diffuse mononuclear exudate in the alveoli and foci of thickening and organization of the alveolar walls consisting of large mononuclear cells and young fibroblasts. Organization set in as the initial œdema subsided and resulted in severe anoxia, which caused many deaths in spite of oxygen therapy. Two dogs surviving this stage showed only focal scars in the pulmonary parenchyma and bronchioles 27 and 59 days after exposure.

G. R. Cameron.

Chlorine Accident in Brooklyn. CHASIS, H., ZAPP, J. A., BANNON, J. H., WHITTENBERGER, J. L., HELM, J., DOHENY, J. J., and MACLEOD, C. M. (1947). *Occup. Med.*, **4**, 152.

A truck with a tank containing 100 lb. of chlorine stopped near a subway entrance and ventilation gratings. Liquid gas escaped from a hole for 17 minutes. There was no visible cloud, but the gas could be smelt 1,000 feet downwind. The dense gas found its way into the subway and 131 individuals from the subway were admitted to hospital, together with 2 who had been in the street. Thirty-three were in hospital for more than a week. The first symptoms consisted of burning of the eyes, nose, and mouth with lacrimation, rhinorrhœa, and increased salivation, cough, choking sensation, and substernal pain; often there was nausea, vomiting, headache, and dizziness, and rarely syncope. All the symptoms except cough, substernal pain, and respiratory distress subsided within 24 hours. In the 33 most severe cases there was tracheo-bronchitis within 24 hours which lasted about 7 days. Pulmonary œdema was observed in 23 patients, and 12 of these, besides 2 others, developed pneumonia. Respiratory distress and substernal pain usually subsided within 4 days. Cough, however, became troublesome after the third day and produced thick tenacious mucopurulent sputum, but in most patients it subsided by the 14th day. Diminution in breath sounds was the most prominent physical sign, while rales and rhonchi were present for up to 2 weeks.

Radiographs showed mottling, patches of irregular density, and differences in the degree of æration of the two pulmonary fields. Of 8 patients who were cyanosed and had extensive pulmonary involvement but no appreciable hæmoconcentration, 6 showed arterial oxygen unsaturation, the values being 91·2, 90·5, 88·1, 84·6, 82·3, and 81·8%. Peripheral venous pressure was within normal range in 7 patients. In 11 there was a slight polymorphonuclear leucocytosis.

Of the 33 severe cases, 15 were treated with sulphadiazine (4 g. followed by 1 g. 4-hourly for 6 days) and 5 of these developed pneumonia; 7 received penicillin (15,000 units 3-hourly), 2 developing pneumonia; and 11 were untreated until pulmonary œdema was present and 7 of these developed pneumonia. Oxygen at atmospheric pressure was administered to all acutely ill patients for up to 96 hours, while oxygen under a positive expiratory pressure of about 4 cm. of water was given intermittently for intervals of 2 to 30 hours to

19 patients. One patient had oxygen under constant inspiratory and expiratory pressure of 6 cm. of water for 5 hours and intermittent expiratory pressure for 48 hours. Administration under positive pressure diminished the subjective sensation of respiratory distress and the objective evidence of respiratory difficulty in 14 of the 20 patients; it also caused a diminution of the adventitious pulmonary sounds. Adrenaline and "aminophylline" given early appeared beneficial and if administered late were without effect. Eleven of the 33 patients were observed for 16 months and during that time there was no evidence that the chlorine had caused permanent damage to the lung. *K. M. A. Perry.*

INDUSTRIAL DERMATITIS

Skin Sensitization to BAL. CORNBLEET, T. (1947). *J. invest. Derm.*, **9**, 281.

A case of personal skin sensitization with BAL is reported and described. The results of tests with portions of the molecule, and with chemical depilatories which were thought to have paved the way for the subsequent sensitization, seemed to show that the entire molecule was responsible. Both the Prausnitz-Küstner passive transfer test and a scratch test gave negative results. *G. B. Mitchell-Heggs.*

A Rare Professional Injury due to *X* Rays. (Eine seltene Berufsschädigung durch Röntgenstrahlen.) KORBLER, J. (1948). *Radiol. clin., Basel*, **17**, 29.

A case of damage to the nails and the skin of the toes caused by *x*-ray screening in mass radiography with insufficiently protected small portable apparatus is reported.—[Author's summary.]

The Sunburn-Protecting Effect of *para*-Aminobenzoic Acid. ROTHMAN, S., and HENNINGSEN, A. B. (1947). *J. invest. Derm.*, **9**, 307.

The method of application of *para*-aminobenzoic acid, the choice of light source, the choice of a base, and the measure of effectiveness are described. Results in experiments with mercury lamps and with sunshine prove this substance to be an effective protective against sunburn. Results of tests on a patient with solar herpes and another with chronic discoid lupus erythematosus were excellent. *G. B. Mitchell-Heggs.*

Coal Tar in Dermatology. An Improvement in its Physical Properties without any Change in its Therapeutic Action. COMBES, F. C. (1947). *Arch. Derm. Syph., Chicago*, **56**, 583.

A new "low temperature retort crude coal tar" does not have the objectionable qualities of crude coal tar but retains in full its therapeutic usefulness. It is miscible with water, forming a colloidal solution, and with collodion, glycerin, oils, and fats. Pastes and ointments made with it are smooth and homogeneous and do not seem to impede exudation or evaporation from the skin surface; they rarely cause acne or pustular folliculitis. Half an ounce of the tar added to a lukewarm bath is non-staining and anti-pruritic. If the tar is removed 15 minutes after application the skin remains sufficiently photosensitized for 72 hours for the Goeckerman treatment. It can be used on hairy parts of the skin and can be removed with water. "Spot-touching" with 10% of the tar in collodion is useful in scattered lesions. Thirty-six patients with various dermatoses have been treated with it satisfactorily. *E. Lipman Cohen.*

Carcinogenic Constituents of Coal-tar. BERENBLUM, I., and SCHOENTHAL, R. (1947). *Brit. J. Cancer*, **1**, 157.

A horizontal retort coal tar of high carcinogenic potency contained at least two potent carcinogens in addition to 3,4-benzpyrene. These substances were fairly closely associated with 3,4-benzpyrene but could be separated from it by chromatography on alumina; a fraction obtained before 3,4-benzpyrene was much more potent for rabbit skin than for mouse skin and a fraction obtained after 3,4-benzpyrene was carcinogenic on both rabbits and mice. The earlier fraction was free from 3,4-benzpyrene as shown by fluorescence spectrography, and was probably responsible for the strikingly different carcinogenic effects of the coal tar and of 3,4-benzpyrene on rabbit skin. The carcinogen most likely belonged to the class of polycyclic hydrocarbons of the 4, 5, and 6-ring systems and their homologues, a homologue of a 4-ring hydrocarbon being considered the most probable. The procedure, which is described, effected a more than 200-fold concentration of the substance present in tar, but the final preparation was still a mixture and the active constituent has not yet been identified. *L. Foulds.*

ACCIDENTS AND ORTHOPÆDIC SURGERY

The Diagnostic Significance of Change in Position of Metallic Foreign Bodies in Brain Abscess. WOOD, E. H. (1948). *Amer. J. Roentgenol.*, **59**, 52.

An account is given of the gross changes in the brain resulting from penetration of a missile, with special reference to Cushing's work on sepsis and hæmorrhage. It is obvious that all retained metallic foreign bodies may be a source of sepsis and abscess formation. The manifestations of this may be atypical, and the value of the work of Cairns, who carried out encephalography on all patients with a retained metallic foreign body, is cited. It is recognized that metal fragments in the brain may change position with formation of an abscess. Some investigators have attributed this movement to the weight of metal and relative softness of brain tissue, but observations indicate that the movement takes place because the metal lies in a cavity formed by abscess or hæmorrhage.

The author examined 175 patients with retained intracerebral metallic foreign bodies during the first few weeks after injury. In 40% there had been primary débridement. In 4 cases the metallic fragment moved; on 2 occasions free gravitational movement took place when the patient was moved, demonstrating that the metal lay in a cavity; in the other 2 cases the metal moved after an interval, as the result of abscess development. It is pointed out that foreign bodies should always be removed from the brain if possible. Abscess formation may be difficult to diagnose clinically, and the demonstration of shifting of a metal fragment may supply the additional evidence needed to decide operative measures. *M. H. Jupe.*

INDUSTRIAL OPHTHALMOLOGY

Ocular Injury Due to Sulfur Dioxide. I. Report of Four Cases. GRANT, W. M. (1947). *Arch. Ophthal., Chicago*, **38**, 755.

Accidental exposure to sulphur dioxide either in the liquid or in the gaseous form may occur in industrial

processes involving refrigeration. The deleterious effects of the liquid form are much more severe because a high concentration is suddenly applied, whereas the gaseous form is well diluted with air and there are signs, such as smell, irritation of the throat, cough, or burning of the eyes, which give sufficient warning for preventive measures. Permanent damage to the eyes is rare in exposure to the gas even when the exposure has been sufficient to lead to death through bronchial and pulmonary involvement.

The 4 cases here reported resulted from the bursting of a refrigerator which caused the eyes to be sprayed with the liquid sulphur dioxide. The immediate results included swelling of the lids, hyperæmia of the conjunctiva with thrombosis of conjunctival vessels, opacity of the corneal epithelium, endothelium, and stroma, and subsequent vascularization. In severe cases the conjunctiva overgrew the cornea and symblepharon also occurred. The grosser changes resembled those resulting from alkali burns, but in the less severely damaged eyes recovery was complete. *A. J. Ballantyne.*

Ocular Injury Due to Sulfur Dioxide. II. Experimental Study and Comparison with Ocular Effects of Freezing. GRANT, W. M. (1947). *Arch. Ophthal., Chicago*, **38,** 762.

Two mechanisms have been held to explain the severity of ocular injuries due to exposure to liquid sulphur dioxide : (1) the freezing produced by rapid evaporation of the liquefied gas ; and (2) the formation of sulphuric acid from sulphur dioxide on the moist mucous membrane surfaces. The lack of evidence to support either of these theories, and the fact that there has been no experimental investigation of the action of liquid sulphur dioxide, led the author to the present research.

In order to eliminate so far as possible any chemical or physical effects other than freezing, the refrigerant "freon −12" was used in experiments on the rabbit's eye. This is a chemically inert substance and produces an even greater freezing effect than sulphur dioxide. Direct spraying of the rabbit's eye with a mixture of oil and freon (in imitation of the probable condition of an accidental exposure in man) caused initially a blanching and hardening of the lids, which in 5 to 10 seconds passed off. A few hours later there was vascular congestion of the nictitating membrane and conjunctiva, and œdema of the corneal epithelium. In 24 hours the central part of the corneal epithelium was denuded, and within 72 hours the conditions were normal. After more vigorous and prolonged application similar recovery occurred, but in about 5 minutes the corneal endothelium became grey, with dark round and oval defects, and more or less complete shedding of the endothelium took place. In the most severely injured eye the reactions progressed, causing great thickening of the cornea, with a bluish transparency and a diffuse fluorescein staining. Within 10 days the cornea became opaque and yellow and sloughed. When the effects of sulphur dioxide were tested under conditions excluding freezing (exposure of the eye for 5 seconds to a stream of pure gaseous sulphur dioxide), results were similar to those obtained with the liquid form, and the permanent changes (opacity and vascularity of the cornea) resembled those produced by severe acid burns. Further experiments showed that the injurious effects of sulphur dioxide are due to the formation of sulphurous acid, and that the changes produced within the cornea are drastic enough to cause inhibition of the enzymes. The epithelium and stroma of the cornea were found to have a relatively high permeability to sulphur dioxide, a property related to the solubility of the latter in lipids ; the severe ocular injury resulting from exposure to sulphur dioxide is due to the high concentration of sulphurous acid and its property of denaturing the corneal proteins, including enzymes.

A. J. Ballantyne.

Clinical Report on Miners' Nystagmus. CAMPBELL, D. A. (1948). *Brit. J. Ophthal.*, **32,** 193.

Forty-four miners under general treatment for nystagmus were studied regularly for 2 years ; every effort was made to get them back to some form of work quickly. The average duration of incapacity was 6 months, and after the 2 years 41 were working. This compares favourably with another series of men who, under a different authority, did not appear to have been supervised in the same way ; of these only 21 out of 43 had found work. About 50% of certified patients appear to be able to take up light work within 3 months of certification, if they are pressed. From her work on cases of miners' nystagmus the author has formed certain opinions, but the data on which they are based are not given. In her opinion the system of certification is unsatisfactory ; a certified man may go without any treatment for months. Patients with nystagmus fall into three grades : those who stay at work with symptomless nystagmus, those who can be certified and have certain subjective symptoms, and those with psychoneurosis who develop blepharospasm on examination. It is suggested that miners with nystagmus should return to suitable work at once, that fitness for work and for certification should be judged from the outset by an ophthalmologist and a psychiatrist, and that men who are unfit for work should be given a holiday and should receive rehabilitation, preferably institutional. Compensation should be such that a return to work is financially attractive. In spite of earlier recommendations in a Medical Research Council report, little has been done to prevent the disease, which affects skilled men in the prime of life. *J. N. Agate.*

The Dark Adaptation of Coal Miners Suffering from Nystagmus. SHARPLEY, F. W. (1948). *Brit. J. Ophthal.*, **32,** 199.

Miners with nystagmus commonly have poor dark adaptation. Controlled tests were made on miners with nystagmus, unaffected miners, and non-miners, to determine the final rod threshold. In the somewhat selected control group the usual continuous increase in the threshold with advancing age was demonstrated. The variability for the same subject tested on different occasions was found not to be significant when compared with the differences between individuals. Some 76 miners with and without nystagmus were tested at periods of months or years from certification. Many of these were in the age group 40 to 50 years. All the individual dark-adapted threshold values were therefore corrected, according to the mean figures obtained from each age group of the control series, to conform with the age group 40 to 50 years, in order to allow for the natural effects of age. The corrected threshold values for all the miners, regardless of symptoms of nystagmus, were substantially higher than the normal figure.

J. N. Agate.

A Comparison of Dark Adaptation in Miners with their Nutritional State. CAMPBELL, D. A., and TONKS, E. (1948). *Brit. J. Ophthal.*, **32,** 205.

Inquiry was made into the state of nutrition of 100

miners, and the levels of vitamin A and carotene in plasma, in conjunction with the dark-adaptation tests reported in the previous paper (see above abstract). Plasma alkaline phosphatase was also estimated to detect any deficiency of vitamin D, which might be expected in miners, and liver function was studied. Men with nystagmus working underground or on the surface were compared with miners in similar circumstances who were not suffering from nystagmus, and with normal controls who were not miners. There was no correlation between dark-adaptation threshold values and the level of vitamin A in the blood, but the latter tended to be higher in non-miners and surface workers than in those with nystagmus or in normal underground workers. Nor was there a correlation between plasma vitamin A or D on the one hand, and age, occupation, or incidence of nystagmus on the other. It appears, therefore, that the raised threshold for dark adaptation previously noted as a constant feature among miners is not due to a lack of vitamins A and D or to any obvious nutritional disturbance. *J. N. Agate.*

The Psychiatric Aspect of Miners' Nystagmus. STERN, E. S. (1948). *Brit. J. Ophthal.*, **32**, 209.

A psychiatric investigation was carried out on 70 men who had been referred from an ophthalmic clinic. The ophthalmic findings were then consulted and the cases classified as : (*a*) certified cases of nystagmus with eye oscillations, (*b*) certified cases without oscillations, (*c*) suspected early cases without oscillations, (*d*) cases with oscillations but at work without symptoms, and (*e*) controls.

The groups containing the nystagmus cases showed a high incidence of hysterical conversion symptoms and anxiety neurosis. The author thinks it possible that the photophobia, subjective rotation of objects, giddiness, blepharospasm, and headaches of men with miners' nystagmus are hysterical. The first two groups above showed a significantly higher incidence of psychoneurotic symptoms than did the controls. Analysis of the past medical and family histories did not suggest that nystagmus could be eliminated by pre-employment selection, nor would this be desirable as these men give many years of active service before becoming disabled. There was no significant difference between the means of the ages of the men in groups *a* and *b*, or between the means of their respective periods of working life before symptoms. The control group is shown not to have been comparable to them in these respects. Amongst social factors, insecurity of employment may be a factor in the ætiology. The oscillations in miners' nystagmus are often circular ; it is suggested that lateral nystagmus is initiated by strong convergence on entering the dark environment and is aggravated by emotional strain, as in night fliers, while vertical nystagmus results from the miner having to look upwards from unusual working positions ; summation of these two motions at right angles could then give circular, elliptical, or diagonal eye movements. Hysterical subjects could perpetuate them even in normal conditions of lighting and working. In general, miners' nystagmus appears to be a psychosomatic condition with eye symptoms, and is related to prolonged work under emotional stress in an awkward position in the dark. Some men show oscillations but have no symptoms, but this does not invalidate this view, for oscillations may be a further stage in the hysterical conversion of symptoms. The high incidence of mild types of mental disorder in all the groups is explained on the grounds that miners are under constant psychological stress ; they also live by disfiguring and laying waste their environment, and are apt to regard themselves as a rejected people. The author suggests that the term "miners' nystagmus" should no longer be used, and that men with symptoms should be referred to a psychiatrist as early as possible ; all such men should be found work above ground at once. The lighting of mines and the miners' posture should be improved, and the men should be given economic security. *J. N. Agate.*

A Comparison of Dark Adaptation with the Psychological State in Miners. CAMPBELL, D. A. (1948). *Brit. J. Ophthal.*, **32**, 225.

Previous work has suggested that airmen with anxiety states have poor night visual capacity. Dark-adaptation threshold tests and psychological states have therefore been compared in miners. There is no significant relation between them. *J. N. Agate.*

Binocular Vision in Miners. CAMPBELL, D. A., HARRISON, R., and VERTIGEN, J. (1948). *Brit. J. Ophthal.*, **32**, 226.

A study of the behaviour of the eyes under conditions of low illumination was made in the hope of finding the mode of onset of miners' nystagmus. Binocular vision in full light and full dark-adaptation was tested on a synoptophore ; in dark-adaptation the illumination was comparable to that at the coal-face, but was not low enough to exclude foveal vision. Stereoscopic vision, fusion, ductions, and simultaneous perception were tested in this order. Miners were found who were working happily at the coal-face with strabismus or with high degrees of hypermetropia but low visual acuity, neither type having binocular vision. In all the subjects tested the subjective angle became convergent in dark-adaptation, but in those with nystagmus this was less marked. In most of them there was abnormal fixation. The number with poor stereoscopic vision increased with advancing years in all groups tested. Compared with a control series of non-miners, the number of normal miners with poor stereoscopic vision was high, but amongst a group of miners with nystagmus it was higher still. Miners, both with and without nystagmus, had greater power of adduction than normal controls if there was good stereoscopic vision, but if there was not they had hardly any power of adduction at all. In men with long-standing nystagmus binocular vision tests are precluded by photophobia, blepharospasm, or psychological abnormality. In the intermediate stages some fusion, duction, and stereoscopic vision are present. In the early stages the nystagmus may be of various types, and some miners with symptoms have no detectable nystagmus, although they have some suppression in one eye, and poor duction.

The authors think that patients with long-standing nystagmus have often developed so severe a psychoneurosis that they are untreatable by the time they are first seen by an ophthalmic surgeon. They suggest that in cases of nystagmus there is breakdown of binocular vision under conditions of low illumination. Stereoscopic vision can be maintained even with low acuity, and is more likely to be due to rapid alternation of monocular impressions brought about by small fusional movements of the two eyes than to summation of stimuli from the two eyes. The explanation of the intolerable symptoms brought about by nystagmus at the age of presbyopia is still to be sought. *J. N. Agate.*

GENERAL

Mortality of *Aëdes aegypti* Feeding on Rabbits Receiving Oral "Gammexane." GARNHAM, P. C. C. (1947). *Nature, Lond.*, **160**, 156.

Lindquist and others (*J. econ. Ent.*, 1944, 37) showed that a high proportion of bed-bugs died as a result of feeding on a rabbit previously dosed with DDT. De Meillon (*Nature, Lond.*, 1946, **158**, 839) noted similar effects in the case of bed-bugs following the administration of "gammexane" to the host, and that *Aëdes aegypti* was also killed. The author has continued and amplified De Meillon's experiments, in so far as mosquitoes are concerned, in order to decide the normal lethal dose of gammexane in similar circumstances and the period during which the effect lasts. The results are set out in two tables, which show that the minimum dose of gammexane which it is necessary to administer to the rabbit in order to render its blood insecticidal lies between 25 and 30 mg. per kilo of rabbit weight. This dosage is apparently the lowest tolerated, since 40 mg. proved lethal to a proportion of the rabbits. It would appear that the concentration of gammexane in the blood rises for some 24 hours after its administration, when dissolved in alcohol and given by mouth, and that its persistence varies according to the amount administered. The maximum period of persistence, for a complete kill, was 4 days after a dose of 40 mg.; with lesser amounts its effects lasted only 2 days. An interesting observation arising from these experiments was that *Aëdes aegypti* still shows a reluctance to feed on animals treated with gammexane, and when it does feed it takes up an average of 2·5 mg. of insecticidal blood; whereas when fed on untreated animals it takes up an average of about 4 mg.

R. M. Gordon.

Insecticidal Effect of Surface Deposits of D.D.T. on Mud. HADAWAY, A. B., and BARLOW, F. (1947). *Nature, Lond.*, **160**, 363.

It is now generally recognized that some of the earlier claims for the lethal action of DDT spray against adult mosquitoes require modification. DDT, when used in high dilution, may leave a deposit insufficient to kill mosquitoes alighting upon it but sufficient to excite the insects and cause them to fly towards light. The resultant disappearance of mosquitoes from lightly treated houses has sometimes led to the erroneous belief that the insects had been destroyed. The authors of the present paper point out that "for residual spraying in houses to be successful in reducing the incidence of malaria, it is essential . . . that the surface deposit applied shall be lethal to mosquitoes after only a brief contact." The types of surface most common in African houses are mud walls and thatched roofs. The efficiency of residual sprays on the former was tested by applying 5% DDT in various bases to standard mud blocks. Biological tests were then carried out with *Glossina palpalis* and *Aëdes aegypti* as test insects. The outer surface of the mud blocks, representing a layer of approximately 0·1 mm. in thickness, was then removed, and the amount of insecticide determined by using the dehydrochalogenation method. The results are summarized in the following table:

	Mean% of DDT in outer 0·1 mm. layer	% *G. palpalis* Killed after Contact of		% *A. aegypti* Killed after Contact of 1 hr.
		15 sec.	15 min.	
Solution of DDT in : diesoline..	8	0	5	10
kerosene ..	13	0	20	10
50% kerosene and 50% cotton-seed oil ..	11	0	25	10
Cotton-seed oil	10	0	15	10
Emulsion :				
"T.P. 543" ..	35	25	75	70
"T.P. 543" + Resin ..	27	5	50	43
Dispersible powders :				
"Geigy Neocid *BA*50" ..	46	100	—	100
"Hyg. Chem. Co. *N*210"	62	100	—	100

Seventy-six per cent. of a "gammexane" dispersible powder 530 was recovered from the outer layer a few hours after application, but the percentage fell to 20 in 10 days.

R. M. Gordon.

***Aëdes aegypti* Control in the Absence of a Piped Potable Water Supply.** DE CAIRES, P. F. (1947). *Amer. J. trop. Med.*, **27**, 733.

The city of Georgetown has some 90,000 inhabitants but lacks a piped potable water supply and, in consequence, presents many pressing problems to those responsible for maintaining the health of the community. The most dangerous threat to the city is probably yellow fever because, although the disease has not been known to occur in the coastal towns since 1909, jungle yellow fever is present in the interior and menaces the cities on the coasts so long as the incidence of *Aëdes aegypti* in the coast cities remains high. Since 1939 the International Health Division of the Rockefeller Foundation has assisted the Health Department of British Guiana; this joint organization, using the classical control methods, was successful in eradicating *A. aegypti* from rural areas, but failed to do so in the urban areas, particularly in the capital, Georgetown. The reasons for this failure are considered in detail by the author, but the main causes were twofold: (1) the occasional occurrence of a "4-day egg-adult cycle" which could not be controlled by the 7-day inspection cycle; (2) the absence of a piped water supply which caused the inhabitants of Georgetown to collect, store, and often hide water by a variety of methods, some of which escaped control because of legal procrastination. In 1945 a small experiment was carried out to test the value of residual spraying with DDT. The result of this experiment was so satisfactory that it caused the classical control measures previously adopted to be considerably modified so as to include residual spraying with DDT; where this method has been employed *A. aegypti* have been completely eradicated. To achieve this result a 5% solution of DDT in kerosene is applied at an estimated dosage of 100 mg. DDT per square foot to walls and low ceilings

at a cost of B.W.I. $0.47 to $0.59 per head of population; in contrast, the much less effective classical methods cost $1.39 per head of population in the rural areas and "infinitely greater" in the urban areas. The author considers that this lowering of cost is mainly due to rapidity of action and persistence of effect of DDT.

R. M. Gordon.

Influence of Endogenous Factors (Ovarian Insufficiency) and Exogenous Factors (Profession) on the Origin of Premature Labour. (Der Einfluss endogener Faktoren (Ovarialinsuffizienz) und exogener Faktoren (Berufsarbeit) auf die Entstehung von Frühgeburten.) KIRCHHOFF, H. (1947). *Geburtsh. u. Frauenheilk*, **7**, 78.

Although since 1901 mortality during the first year of life has fallen considerably, mortality at birth and in the following 10 days has not decreased proportionately. Although some of the deaths may be explained by developmental abnormalities, the majority are due to unknown factors, among them probably the social status of the mother and whether or not she works during pregnancy. Some 13,000 cases were examined from this point of view; 40 to 50% of pregnant women were found to be at work in different years of the analysis. In those who worked, the percentage of premature births was 15·2; in those who did not work 10·5; detailed analysis showed varying percentages according to the type of work done (for example, 17·2% in industrial factory workers, and 11·8% in those working in hotels). In the working group the membranes ruptured prematurely in 41% of all births compared with 30% in the other group. Premature labour was less common if there was a period of rest at the end of the pregnancy; in those who did not rest the percentage of premature births was 26 to 36, compared with 6·5 to 10% in patients who did not "work" for 70 to 90 days before delivery. It appeared that birth weights were higher in the "resting" group and that pregnancy was prolonged slightly in the industrial worker.

Kenneth Bowes.

A Study of the Health Hazards of the Tobacco Stemming and Redrying Industry. MCCORMICK, W. E., SMITH, M., and MARSH, S. P. (1948). *J. industr. Hyg.*, **30**, 43.

Several of the operations performed in processing leaf tobacco are dusty. In the operation of "stemming" the centre stem is mechanically removed from the leaf, and in that of "cleaning" the final particles of leaf are removed from the stems. In the "hanging-blending" process bundles of tobacco from various piles are manually shaken and beaten in order to remove foreign matter. The dust may contain insecticides such as lead arsenate. Numerous analyses were made of atmospheric samples collected by means of an all-glass large impinger. Those from the operations of hanging-blending, stemming, and cleaning had an average content of 5·7, 7·8, and 9·5 million particles per cubic foot, respectively. They contained 0·4, 0·96, and 0·9 mg., respectively, of lead per 10 cubic metres, and 0·06, 0·21, and 0·17 mg. of arsenic. The maximum quantities observed were 3·8 mg. of lead and 0·95 mg. of arsenic per 10 cubic metres. The maximum concentration of lead allowed by the American Standards Association is 1·5 mg. per 10 cubic metres, and this value was not infrequently exceeded, but the allowable maximum for arsenic was never reached. On the basis of the free silica contents found, the maximum allowable concentration of dust particles in the air should probably not exceed 10 million particles per cubic foot, but many of the impinger samples analysed exceeded this value to some extent. No information is available of the maximum allowable concentration for nicotine. The impinger samples for hanging-blending, stemming, and cleaning had an average content of 0·22, 0·45, and 0·53 mg., respectively, of nicotine per cubic metre, and the small amount of evidence available suggests that the concentrations observed did not present a significant health hazard.

No physical examinations of the employees at any of the processing plants were made, and there is no evidence that the dusts were actually harmful. Many of the employees had been in the industry for a number of years.

H. M. Vernon.

Clinical Observations and Experimental Cases of Swineherd's Disease. (Osservazioni cliniche e ricerche sperimentali su alcuni casi di malattia dei porcai.) BOLOGNA, R. (1947). *G. Batt. Immun.*, **37**, 399.

Swineherd's disease is relatively rare in Italy; 7 cases are described from Savoy in persons working with pigs. There were changes in the cerebrospinal fluid and in 2 there were meningeal symptoms. A rash was present in 4 cases. Durand and his colleagues (*C.R. Acad. Sci., Paris*, 1936, **203**, 830, 957, 1032) showed that blood filtered through an L2 but not through an L3 candle. The filtrate was infective for man, the incubation period being 7 to 14 days. In 1947 Gsell (*Pr. méd.*, 1945, **53**, 525) brought forward evidence to show that swine fever was due to a leptospira, *L. pomona*, which was isolated from the blood. Similar leptospira were found in the urine of a healthy man. Sera from recovered cases are said to agglutinate the leptospira in a dilution above 1 in 1,000.

[It is not impossible that more than one condition is being labelled swineherd's disease merely because the illness occurs in those who deal with pigs.]

G. M. Findlay.

PROCEEDINGS OF THE ASSOCIATION OF INDUSTRIAL MEDICAL OFFICERS

FIFTY-FIRST MEETING

The Fifty-First Meeting of the Association was held at the London School of Hygiene and Tropical Medicine on Friday, April 30, and Saturday, May 1, 1948. The President, Dr. A. J. Amor, was in the Chair, and fifty-one members were present.

Private Business :

Election of Honorary Member

Dr. T. Bedford, Head of the Medical Research Council Research Group in Industrial Physiology, was elected unanimously to Honorary Membership. The President said that Dr. Bedford, whose distinguished work on the environmental aspects of public and industrial health was well known, would be warmly welcomed as an Honorary Member of the Association.

Public Business

Dr. E. R. A. Merewether, H.M. Senior Medical Inspector of Factories, delivered the first John C. Bridge Memorial Lecture, entitled "The British Tradition in Industrial Health" (see p. 175 of this issue). In introducing the speaker, the President paid a tribute to the memory of Dr. Bridge, a former Chairman of the Association, who had been one of the pioneers of industrial medicine in this country. The Bridge Memorial Lecture would be given every two years to honour the memory of a great tradition and a great man.

The Association Dinner at which forty-three members were present, was held at the Connaught Rooms, Kingsway, London, on April 30. The President introduced an innovation by inviting three members to speak on "the Development of the Association of Industrial Medical Officers." Dr. Meta Mackenzie (Messrs. J. Lyons and Co.) suggested that more visits should be paid by industrial medical officers to each others' factories, as there was always something useful to be learnt by an exchange of views. Social contacts and discussions would also be welcomed. Dr. Faulkner-Hudson suggested that members could be kept better informed of the activities of the Association by the publication of a quarterly bulletin, possibly in the form of a "news letter." Dr. H. J. Davies (London Transport Executive) suggested that a reference library of works on industrial medicine should be formed. He would like to see more opportunities for inviting wives and guests to social meetings, and suggested that the present annual subscription was too small to allow much further development of the Association's activities. A number of other members made suggestions, which included arrangements for a closer collaboration between industrial medical officers and laboratory workers ; the appointment of a scientific secretary ; publication of a bulletin on everyday problems ; and the publication of a list of members on an industry basis. Much discussion was aroused by the various suggestions.

On Saturday, May 1, Dr. J. E. Sisson, of Imperial Chemical Industries Ltd., addressed the Association on "Plastics : Some Problems of a New Industry." Forty-five members were present. Dr. Sisson first gave a brief account of the history of plastics, with particular reference to celluloid, first produced in 1870. The plastics industry was not therefore a new one, though it is still young. The total output of plastics in this country was probably of the order of 100,000 tons a year ; this was much smaller than the output of the conventional raw materials, and it was clear that the plastics industry, even if its materials were suitable, could do little to solve any of our major raw material shortages. Dr. Sisson then briefly described the natural plastics—shellac, used in varnishes and gramophone records—bitumen, used with asbestos filler in battery boxes—and vegetable resins, such as dammar and copal, used in paints. It would probably be long before these natural plastics were superseded for their particular uses. A simple definition of plastics might be attempted as follows : "Plastics are organic chemicals containing long chains of carbon atoms, which are, at some stage of their manufacture, capable of flow under heat and pressure."

The synthetic plastics could be divided into three classes according to how the long chains of carbon atoms were built up. In the *first class* were the primitive synthetic plastics, in which nature had built up the long chains of carbon atoms and the chemist had modified the natural products to make them more tractable. The cellulose plastics, for example, were made by modifying the cellulose chain of some 2,000 glucose units. In the casein plastics the chemist but slightly modified the proteins occurring in milk. New modifications of this class of plastics might be discovered, but it was unlikely that any strikingly new properties would emerge.

In the *second class* of synthetic plastics were those with long chains of carbon atoms built up synthetically by the chemical process of condensation. The best known example was phenol formaldehyde, in which phenol was condensed with formaldehyde to produce "Bakelite" moulding powders. Similarly, urea could be condensed with formaldehyde to give lighter coloured moulding materials which did not suffer from the defect of darkening on exposure to sunlight. In the pure form, these resins were brittle and were therefore usually compounded with some fibrous filler to increase their impact strength.

The *third class* of plastics known as the synthetic polymers, showed the most interesting and promising developments. An example was polythene, with a molecular weight of about 20,000 and a chain length of about 1,500 atoms, made by polymerizing ethylene at a pressure of about 1,000 atmospheres. Polyvinyl chloride (PVC) of a chain length of about 2,000 atoms, was made by polymerizing vinyl chloride produced from acetylene and hydrochloric acid ; it was not a synthetic rubber in

the true sense but had valuable properties as a substitute for rubber. The acrylic resins, of which "Perspex" is an example, had a chain length of about 1,000 atoms and consisted of polymerized methyl methacrylate. The development of this class of plastics was of interest because the chemist could predetermine the molecular weight of the synthetic polymer and could control within narrow limits the properties of the finished plastic.

Dr. Sisson showed a colour film illustrating the processes of fabricating plastics, demonstrating laboratory equipment, and showing the manufacture of a "Perspex" powder bowl. In regard to future developments, Dr. Sisson said that new materials and new applications would be found, and he gave as examples of recent developments, polytetrafluorethylene, new synthetic fibres (for example, "Terylene"), and acrylic optical systems. In the last of these, the mass production of lenses from moulds was much cheaper than the grinding of glass lenses, and should lead to great development of visual education.

Dr. Sisson said it was important that the industrial medical officer should not confine his activities to his office or surgery. He had a place in the industrial team and should be well known in the factory and laboratory; he would be asked to pronounce on the hazards likely to arise from the industrial use of products which had hitherto been merely laboratory curiosities; he might also be asked whether new products were suitable for special applications, such as packages for foodstuffs, or materials in contact with the skin. The help of the industrial medical officer, given at an early stage in a new development, might shorten by months, if not years, the lengthy business of transferring a good idea into an industrial reality.

In the discussion, Dr. Sisson said that "Perspex" had not been widely used for ordinary spectacle lenses, although they were suitable for special applications where the non-splintering properties of the material were an advantage. The fluorine plastics were of very recent development. Dr. Harris said that the plastic itself (polymerized tetrafluorethylene) was entirely inert as regards any fluorine hazard, but that under certain conditions the polymer might disintegrate, and this was not without risk although the escape of fume could be controlled. The toxic product evolved was unknown; it had been thought to be hydrogen fluoride, but there had been instances of up to three hours' delay before the onset of symptoms. In the case of formaldehyde, the usual enclosure to prevent fume, together with protection of the worker, was necessary. Barrier creams were generally not satisfactory, but the sulphonated castor oils had been found the most useful.

The President thanked Dr. Sisson for his address, which, he said, directed the attention of industrial medical officers to important developments and possible hazards in this rapidly expanding industry.

LONDON GROUP

Chairman: Dr. S. W. Fisher,
Ministry of Fuel and Power.

Hon. Secretary: Dr. R. E. W. Fisher,
South Metropolitan Gas Co., Old Kent Road, London.

On April 5, 1948, twenty-two members of the London Group visited Chislet Colliery in the Kent Coalfield by invitation of Dr. S. W. Fisher, of the Ministry of Fuel and Power. Members were able to observe working conditions in the mine and in particular at the coalface, where one of the experimental installations of fluorescent lighting had been made.

At a meeting of the Group held on April 14, at the London School of Hygiene and Tropical Medicine, Mr. A. M. Bryan gave a lecture entitled "A Day in the Life of a Miner." This comprehensive study of coal-mining was illustrated by slides, some of which showed the continual hazards to which a miner was exposed in the early nineteenth century. Not only did he work in damp conditions, with a tallow candle for light, with women and children hauling away at the coal so laboriously obtained, but he risked his life daily since explosions were common at that time. Gradually things improved: to keep the water out, shafts were sunk on a more scientific basis. Collapses were prevented by "packing" with stones the spaces left after removing coal. Firedamp tests, the Davy lamp and its modifications, and the covering of the surface coal with stone dust, were only some of the measures introduced to lessen the risk of explosion. Today, the modern mine with its elaborate machines for undercutting coal, its conveyors and underground locomotives, its improved lighting and general regard for the welfare of the workers, bears little resemblance to its forerunner of a hundred years ago.

BIRMINGHAM GROUP

Chairman: Dr. Donald Stewart,
Chief Medical Officer, Austin Motor Co. Ltd.

Hon. Secretary: Dr. J. G. Billington,
General Electrical Co., Witton, Birmingham.

A meeting was held on March 16, 1948, at which Dr. W. R. Martine, Senior Assistant Medical Officer of Health, City of Birmingham, delivered an address on the control of infection from food.

Dr. Martine said it was important that the industrial medical officer and the medical officer of health should work closely together towards the eradication of the drain on manpower that infected food was apt to cause in industrial workers, as in other sections of the community. Food might become infected in a variety of ways, through the agency either of animals or humans.

(*a*) *Animal:*

(i) Cows might give milk infected with tubercle bacilli, *Brucella* of undulant fever, streptococci, etc.
(ii) Rats and mice might contaminate stored food with organisms of the Salmonella group.
(iii) Flies fed on human excreta and might later contaminate food with fæcal organisms.

(*b*) *Human:*

(i) A milker might infect milk with streptococci, tubercle bacilli, or diphtheria.
(ii) A carrier of typhoid or dysentery might infect food or utensils.
(iii) Septic sores on the finger or elsewhere might introduce streptococci or staphylococci into food or drink.

Many foods provided ideal conditions for bacterial growth during preparation and storage for, apart from time, only moisture, nourishment, and warmth were required. Milk and meat products were particularly good media, and a temperature of 170° F. had to be reached to kill all pathogenic bacteria quickly; refrigeration would not kill them as this merely inhibited growth.

Many foods had, from time to time, been incriminated as causing food poisoning or intestinal infections of one kind or another. The more common included: (*a*) milk

and ice cream ; (*b*) made-up meats (brawn, potted meat, pies, sausages, rissoles, faggots, etc.) ; (*c*) manipulated meat, for example *à la mode* beef ; (*d*) ground fruits and vegetables ; (*e*) shellfish ; (*f*) duck egg ; (*g*) dried egg.

Like most other cities, Birmingham had had its outbreaks of food poisoning, and Dr. Martine referred in particular to three small recent outbreaks which affected one office and two works' canteens.

(*a*) *Office Canteen* (long established).—Fifteen cases of acute diarrhœa and vomiting. Investigation of ingredients used in the preparation of a suspected meal showed nothing, but it appeared that one food-handler had taken half a day off work two days previously on account of diarrhœa, had not consulted a doctor, and had returned to work before recovery was complete. The same organism was isolated from her stools as was found in two of the three worst sufferers whose fæces were examined.

(*b*) *Works Canteen.*—Everyone who had eaten *à la mode* beef on a particular day suffered from an acute attack of vomiting and diarrhœa. Investigation of the source of supply showed that a large number of individual customers had also suffered, while the man who had prepared the meat was found to be suffering from an infection of the nose and throat due to the staphylococcus, the same organism as was isolated from the remains of the meat seized at the canteen

(*c*) *Works' Canteen.*—An extensive outbreak among staff, with a few cases also from the works. The staff had had meat minced at the butcher's and cooked for about one and a half hours, while the works had had stewing steak from the same source cooked for about three hours. The remains of the uncooked stewing steak were found to be contaminated with *Shigella Newcastle*. Investigations were still in progress to try to find a carrier, but there was no definite evidence yet. The outbreak was, however, sufficiently typical to warrant mention.

This toll upon health had been much criticized of late in the medical and even the lay press. The Central Council for Health Education organized a conference in London in October, 1947. In summing up, Dr. R. Sutherland, Medical Adviser and Secretary of the Council, stressed the need for convincing the mother and housewife that hygienic conduct in her kitchen was important. Local authorities must be given powers with which to ensure control of these infections, while managements should no longer be allowed to put forward pleas of shortage of staff, materials, and equipment, to justify poor standards. A general improvement was undoubtedly required in the domestic kitchen before we could expect perfection in the communal kitchen. Domestic perfection would also lead to the closure of poor types of eating house.

The extent to which meals were eaten away from home was referred to by several speakers at that conference. Rationing and transport problems predisposed to this, and the shortage of domestic help and the employment in industry of many housewives created a greater demand than ever for prepared foods necessitating food-preparation premises of all kinds and dimensions, many of them little more than improvizations. These might be temporary structures or conversions of existing buildings ; they were either unsuited basically to this purpose, or their trade had so expanded since their opening that they had become unsatisfactory. Many were now so overcrowded that hygienic management was frequently an impossibility.

Extension of communal feeding had introduced yet another problem—that of staff. The demand for staff for canteens and restaurants had brought into the catering trade a large number of untrained people with little or no knowledge of the risks to which they might expose the public.

Legal provisions fortunately existed, but the laws governing registration of food-preparation premises did not apply to works canteens. Section 13 of the Food and Drugs Act, 1938, set some kind of standard, however, and within limits should be helpful. In this Section, it was not required that a nailbrush should be provided as well as hot and cold water, soap, and towel. No provision existed for sufficient fly-proof food storage accommodation ventilated to the external air.

Were we, as medical men and women, taking our rightful place as leaders of public opinion in this matter ? Did we refuse our own child's request for ice-cream sold unwrapped from the top of a barrow at the street corner ? Did we insist that milk bottles were thoroughly washed before they were put outside our front doors for collection by the roundsman ? Did we always give that word of advice, encouragement, or criticism that might do so much ? Had we seriously interested ourselves in the cooking and serving arrangements in our works canteen ? Much could be done by a personal approach at the managing-director level, by inspections and re-inspections, by lectures for food-handlers, and by debate. The local authorities were always prepared to help in this way, and also in planning any new canteen or extension. The Central Council for Health Education was also prepared to help ; and it was worth while to use appropriate visual aids—films, film strips, and charts.

Managements could do much to improve even the best of premises. A circular had recently been sent to all food-preparation premises in Birmingham drawing attention to the increasing incidence of infection from contaminated food and drink and making suggestions to lessen it. The premises included all hotels, restaurants, cafés, civic restaurants, factory and office canteens, milk bars, public houses, ice-cream premises, cinemas, and fish restaurants. These suggestions were as follows ;

A satisfactory medical history as to typhoid fever, dysentery, and pulmonary tuberculosis should be required from anyone it was proposed to employ in the handling of food. The Army did not employ in a kitchen any man who had had typhoid fever. Why, therefore, should a civilian be allowed to do so ?

Second, a register of all food-handlers should be maintained on the premises. This would be an extension of the Army's nominal roll of cooks, and would include all those engaged in preparing and handling food and those employed in the washing of utensils. Such a scheme had been in use in a variety of premises in Birmingham and proved easy to apply. It was suggested that the register should include the following details of each food-handler : name, home address, name and address of medical attendant, occupation, date of beginning work, medical history on engagement, and dates of any absences from work because of sickness, with details of the cause of absence as stated on the patient's National Health Insurance certificate, or as stated by the patient in the event of illness so short that medical attention was not received. During investigation of an outbreak such a register, carefully maintained and up-to-date, could be of much value in apportioning responsibility or clearing a kitchen of such responsibility.

Third, anti-fly measures were important. Where premises were adequately large, it should be easy to keep tables, shelving, floors, and utensils clean and free from

anything attractive to the common housefly. A suitable refuse container in the kitchen for temporary collection of scraps should have a fitting lid, and should be emptied into the large standard refuse bin outside. Walls and shelves, once they were clean, should be sprayed with an insecticide containing 5 per cent. DDT, and this should be repeated at six-weekly intervals between April and October. A darkened larder would attract fewer flies than one brightly lighted. Most important was the removal of the breeding ground: without that, no other measures could succeed.

Fourth, washing-up arrangements must be satisfactory. A continuous supply of running hot water was essential. In large premises there should be washing-up machines or facilities for sterilization by boiling or steam jet. There should always be two sinks, one for soaking utensils in hot water with a detergent, and the other for final cleansing. Sterilization by hypochlorites served as an alternative to sterilization by moist heat only when the articles to be treated had first been thoroughly cleansed in very hot soapy water.

Fifth, an exhortation to wash the hands should always face an employee when he leaves the lavatory.

Infestation with rats or mice should be dealt with by the specialist officers of a local authority or by firms contracting to do this work.

NORTH-WESTERN GROUP

Chairman: Dr. E. Holland,
Mersey Docks Medical Service, Liverpool.

Hon. Secretary: Dr. G. Taylor,
A. V. Roe, Ltd., Greengate, Middleton, Manchester.

A Meeting of the North-Western Group of the Association of Industrial Medical Officers was held in the Nuffield Department of Occupational Health, University of Manchester, on March 17, 1948. Dr. E. Holland was in the Chair and thirty-eight members and guests were present.

Dr. H. F. Chard, Principal Medical Officer, Royal Arsenal, Woolwich, addressed the meeting on ophthalmological problems in industry. He said that approximately 6 per cent. of cases of total blindness were due to injuries at work, and that the report of the Chief Inspector of Factories for 1946 showed that eye injuries were the second single largest cause of reportable accidents. He classified the causes of eye injury into four groups: traumatic, toxic, radiations, and miners' nystagmus.

In the traumatic group most of the more serious eye injuries were due to perforating intra-ocular foreign bodies caused by the striking of a hard metal object such as a chisel with a hammer. In the toxic group were some of the more common conditions resulting from the remote effects of inhalation or ingestion of toxic substances. In the radiation group effects of infra-red and ultra-violet rays were mentioned. Miners' nystagmus did not fall into any classification and must be regarded as a separate clinical entity.

Dr. Chard described the common abnormalities, both congenital and acquired, which might be met with, and said that the report of the Chief Inspector of Factories showed that eye conditions accounted for the second highest single cause of rejection in the examination of young persons by examining surgeons. He described the importance of the pre-employment medical examination, and emphasized the need of periodic re-examination, especially in certain occupations.

He then outlined the statutory requirements of the employer, with special reference to Section 49 of the Factories Act, 1937, and the Protection of Eyes Regulations, 1938. He emphasized the importance of education, instruction, and supervision of all workers, and in particular of young persons entering industry for the first time. Other sections of the Factories Act had a bearing on this, namely Section 4 dealing with ventilation, and Section 47 dealing with the removal of dust and fumes. Dr. Chard referred to Section 5 of the Factories Act, which requires sufficient and suitable lighting, the Standards of Lighting Regulations, 1941, and Sections 5 and 1 of the Act, which dealt with cleanliness of the factory.

Dr. Chard also mentioned the new interest in the practical and æsthetic advantages of colour in factories.

NOTTINGHAM GROUP

Chairman: Dr. G. E. C. Collis,
Messrs. Ransome Marles Ltd., Newark.

Hon. Secretary: Dr. J. Magill Young,
The Brush Electrical Engineering Co. Ltd.,
Loughborough.

A Meeting of the Nottingham Group was held in the Black Boy Hotel on Thursday, April 15, 1948. Dr. G. E. C. Collis was in the Chair and fourteen members were present. After the meeting there was a dinner, at which the Chairman introduced Dr. F. A. E. Silcock, Consulting Dermatologist to the Leicester Royal Infirmary, who opened a discussion on skin diseases in industry.

Dr. Silcock said that a day or two previously he had been reading a learned tome on skin diseases in which it was stated that the first important thing with regard to industrial workers was the selection of candidates for employment in the industry and that the following were to be excluded: anybody with previous personal or family history of allergy (asthma, hay fever, migraine, etc.) or skin trouble, those with an excessively greasy skin, such as adolescents with acne vulgaris, those with a particularly dry skin or any tendency to ichthyosis, those who were blond-complexioned, those who perspired excessively, and those who did not perspire enough. He began to wonder if one could get anyone to fulfil all the above requirements. In fact, during the war, and even now in most industries, one was thankful to find any applicant to take on work, no matter what the condition of their skin might be.

The investigation of industrial hazards was very important and must be done by practical medical men who went into the works and saw and knew the actual processes.

Dr. Silcock spoke of a mild dermatitis resembling a fungus infection on the thenar eminence of the left thumb, which frequently occurred in hosiery examiners inspecting silk stockings, which were turned inside out over the left hand and forearm. He also mentioned Raynaud's Disease affecting the fingers and hands in workers using a vibration tool for pounding up the soles in the boot-and-shoe trade, where the vibrations were in the region of 23,000 to 30,000 per minute.

Dr. Silcock thought that barrier creams were practically useful only in the milder types of manual work, such as biscuit- and confectionery-making, but he could not think of any barrier cream at the moment that would stand up to the hard wear and tear of working on a capstan lathe in an engineering shop, using warm oil or suds as a coolant, or in the hard and hot work of an iron foundry. He thought the use of barrier creams had a psychological effect.

Dr. Silcock had seen dermatitis in workers proofing

felt hats which are moistened with a solution of sulphuric acid and then dipped in a solution containing shellac and borax. It also occurred among workers making buttons with a thermo-labile plastic that altered its composition at the moment of contact with heat and pressure in the process of moulding. Apparently the powder was quite innocuous until the moment it was so treated, and then it became very irritant in contact with the workers' skin. The exact cause of the trouble was not certain, but the results were obvious.

Workers in the engineering trade sometimes suffered from oil folliculitis or an oil rash or a combination of the two, the complaints being much more common in those who did not wash properly or who omitted frequent changing of their soiled garments. The problem was mainly a mechanical one, in as much as the oil used at this work penetrated into the workers' hair and sebacious follicles of the skin and caused a mechanical blocking and resulting irritation of the skin, sometimes leading to the formation of pustules. Occasionally dermatitis was produced by suds which were a mixture of washing soda and soluble oil, and this might be due to the NaOH or to the oil content.

During the discussion Dr. Silcock said there was an increase in skin complaints at present, particularly those associated with pruritus or an urticarial rash. The reason was probably dietary, a disorganized metabolism showing itself in irritable spots and generalized skin irritation. There was also the nervous tension under which people existed at present; there was a close association between the central nervous system and the skin.

In regard to the incidence of epidermophytosis of the feet, the speaker stated that in his opinion most of these cases were secondary to hyperidrosis and/or bromidrosis. The fungus infection was a secondary invader on an already vulnerable epidermis. He doubted whether primary fungus infection without a predisposing factor often occurred in adults except in infection from cattle to a human source. Treatment should combat excessive perspiration and should be antiseptic in nature. Many cases labelled epidermophytosis of the feet or hands were often dysidrosis with a pompholyx-type eruption affecting these parts, and were of constitutional origin.

TEES-SIDE GROUP

Chairman: Dr. R. W. Murphy, O.B.E.,
Skinningrove Iron Co. Ltd., and Tees-side Bridge and Engineering Co. Ltd.

Hon. Secretary: Dr. J. B. Adamson,
Ministry of Fuel and Power, Newcastle-on-Tyne.

At a Meeting of the Group held on Wednesday, Dec. 10, 1947, at I.C.I. Billingham, Dr. J. B. Adamson, Regional Mines Medical Officer, and Dr. W. Gillies Annan, Medical Referee (Dermatologist) Durham County and North Yorkshire, read a paper entitled "Epidermophytosis: an Account of Measures taken in an Endeavour to Control the Spread of Infection amongst Users of Pithead Baths."

The speakers said that epidermophytosis, tinea pedis, or Athlete's foot, was probably more widespread than was commonly thought, because in its earliest stage (vesiculation and mild scaling) it was not particularly troublesome; and with normal foot hygiene it might not progress beyond this stage. Such mild cases might serve to spread infection. With insufficient care the disease caused fissures to appear at the bases of the interdigital clefts or intertrigo on the opposed surfaces of the toes. The intertrigo consisted of raw, reddened patches surrounded by a rim of dead white epithelium. This led to vulnerability, friction, and trauma, and the fissures served as portals of entry for the pyogenic organisms which might result in abscesses, cellulitis, lymphangitis, and secondary dermatitis of the dorsal aspects of the feet and toes. It was this stage of the disease which brought about incapacity, and in most cases treatment was not sought until this happened. Hyperkeratotic forms of the disease due to the piling up of dead epithelium between the toes were also met with, and more rarely a sensitization dermatitis affecting the trunk and limbs.

Prophylactic measures relative to contagion and/or exogenous infection consisted chiefly of careful personal hygiene, suitable footwear, and the treatment of all suspicious cases with "Aero-ped" ointment. Phenyl mercuric lactate foot baths were to be recommended if available. Daily treatment with mild fungicides was preferable to occasional treatment with strong preparations. Phenyl mercuric nitrate was to be recommended for its high potency, low toxicity, the fact that its action was unimpaired by the presence of body disintegration products, and its absence of smell.

The speakers also suggested making socks with fingers like gloves, and of impregnating them with an active fungistatic. If this could be accomplished without deleterious effects to the patient or the socks the problem of prevention and treatment might well solve itself.

Twelve members were present and all took part in a discussion.

SCOTTISH GROUP

Chairman: Dr. D. Gordon Robertson,
I.C.I. Ltd., Stevenston, Ayrshire.

Hon. Secretary: Dr. William Hunter,
William Collins Sons and Co. Ltd., Glasgow, C.4.

Meetings of the Scottish Group of the Association of Industrial Medical Officers have been held once monthly during the quarter ended March 31, 1948.

On Jan. 14, 1948, a paper was read to the Group by Dr. John B. Gaylor, Lecturer in Medical Neurology in the University of Glasgow, on industrial care and rehabilitation of the neurological patient. This paper, which dealt with a wide range of neurological conditions and the environmental conditions, both physical and psychological, best suited to such disorders, was followed by considerable discussion.

Prof. R. C. Browne, Professor of Industrial Health at Durham University, addressed the Group on Feb. 4, 1948, his subject being the organization of a department of industrial health. He sketched the origins and growth of the University Department of Industrial Health at Durham and, after indicating its present functions, discussed the most profitable development of the Department in the future.

Members of the Group visited the Valleyfield Paper Mills at Penicuik, near Edinburgh, on March 10, 1948. Guides provided from the staff conducted sections of the party over the mills. Discussion followed in which the works management took a leading part. The difficulties facing a business of moderate size in its efforts to provide optimum health conditions for its workers, the poor prospects of such efforts being successful without the full and genuine co-operation of the employees, and methods of obtaining such co-operation were the main themes of the discussion.

OBITUARY

THOMAS GWYNNE MAITLAND

M.A., B.Sc., M.D., D.Phil.

Dr. Thomas Gwynne Maitland died suddenly at his home in Cheshire on Aug. 10, 1948. He was medical superintendent of the Cunard White Star Company for twenty years. Born at Merthyr Tydfil in 1875, he was educated at University College School and at the Universities of Edinburgh, Manchester, and Paris. He graduated M.B., Ch.B., at Edinburgh University in 1907, and obtained his M.D. with distinction in 1908. He became a doctor of philosophy of Manchester University in 1911. His early experience was varied and unusual. At one time or other he was demonstrator in physiology at Manchester University, editor of the Manchester *Medical School Gazette*, lecturer in physiology at the Universities of Wales and Birmingham, honorary physician to Walsall General Hospital, lecturer on psychology at the Birmingham Midland Institute, and director of the typhus colony in Serbia during the first world war as a lieutenant-colonel in the Serbian Army. He contributed numerous papers to medical and psychological journals, and in 1918 published his *Examination of the Basis of Personality*. In 1920 he joined the Cunard Company and in 1926 was appointed its medical superintendent, a post for which he was pre-eminently suited by his rich experience and by natural aptitude and technical ability. He retired in September, 1946.

From the beginning of his entry into this branch of occupational health his aim was to improve the lot of the merchant seaman, and the outstanding contribution to this end made by the Cunard White Star Company during recent years, with its resulting effect on conditions in the Merchant Navy as a whole, is due in great measure to Dr. Maitland's personal influence. His interest took him beyond the sea and its peculiar hazards, however, and the allied problem of industrial disablement with its economic and social repercussions soon became to him an issue of the first magnitude. In this field his influence behind the scenes was great. It is little known, for instance, that he was one of those initially responsible for the setting up of the B.M.A. Committee on Fractures, whose report in 1935 heralded a new era in orthopædic and accident surgery; that he was an international authority on workmen's compensation; or that he was a powerful influence in the formation of the policy of the Birmingham Accident Hospital several years before it opened in 1941. One keen ambition of his was to see founded an accident hospital in Liverpool, and to this end plans were continually in his mind. As far back as 1935 his conception of rehabilitation and his clear view of the need for new and comprehensive legislation as the only means of solving issues bound up with resettlement and workmen's compensation were well in advance of contemporary medical and sociological thought.

Dr. Maitland had an unusual capacity for making and retaining friendships. To him this was no easy matter, but, his mind made up, he was a friend for life. He gave much. Behind the apparent physical frailty was a high courage, an obvious integrity, and a deep consuming energy based on a passionate desire to help the underdog. He was modest to a fault and abhorred publicity. As a host he was beyond compare, a supreme cosmopolitan. But perhaps his most appealing asset was his sense of humour, combined with an uncanny ability to debunk the pedant. It was not in him to suffer fools gladly, but he was essentially a man of gentleness and much understanding. To those whose privilege it was to come within his circle of friends his death meant an irreplaceable loss. Medicine can ill afford to lose its philosophers, and Dr. Maitland truly was one of them in high degree. His contribution to the welfare of seamen and disabled workers throughout the country, acknowledged too little during his life largely because of his own wish, now demands nothing less than the fullest recognition. D.S.

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